woolpert

PROJECT PLAN
#074759 - 2015 NCTCOG PROGRAM

PROJECT PLAN PREPARED BY: SCOTT DUNHAM

CLIENT CONTACT INFORMATION

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SUB CONSULTANTS

Ground Control
Gorrondona & Associates, Inc.

True Orthos
Bohannan Huston, Inc.

WOOLPERT WORK PHASE RESPONSIBILITIES

074959 NCTCOG 2015	
Phase 90 Ground Control (Sub – Gorrondona)	Scott Dunham
Phase 01 Image Acquisition	Daniel Burke
Phase 02 LiDAR Acquisition	Daniel Burke
Phase 03 LiDAR Processing	Mike Meiser
Phase 04 Hydro	Mike Meiser
Phase 05 Image Processing A/T	Joe Cantz
Phase 06 Orthos	Doug Joos
Phase 91 True Orthos (Sub – BHI)	Scott Dunham
Phase 07 Contours - Compilation	Brian Foster
Phase 08 Contours - Cartography	Brian Foster
Phase 09 SmartView QA/QC Delivery	Joe Cantz
Phase 10 SmartView WMS	Jon Downey
Phase 80 QA/QC	Scott Dunham
Phase 98 Project Management	Scott Dunham
Phase 99 Expenses	Scott Dunham

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	Other - Marketing/Client Services		

PROJECT OVERVIEW

The North Central Texas Council of Governments (NCTCOG) program is a five year contract to perform Photogrammetric, Surveying, and GIS services. Woolpert will be providing orthoimagery, LiDAR, and contour services for the 2015 project, the third year of this contract. The NCTCOG region includes 16 counties consisting of Dallas, Tarrant, Collin, Denton, Rockwall, Kaufman, Wise, Johnson, Hood, Erath, Hunt, Navarro, Ellis, Somervell, Palo Pinto, and Parker, which cover approximately 12,800 square miles.

On a yearly basis, NCTCOG coordinates with local public agencies to determine the need for geo-spatial services. Based on participant interest the project area and project deliverables will be defined each year by NCTCOG and its participants. Each year the flight constraints and deliverables change and it is possible that in some years participation may fall to a level that NCTCOG elects not to provide a collaborative flight under this arrangement.

OVERVIEW OF SPECIFIC ELEMENTS OF TECHNICAL APPROACH FOR 2015

Project Area

The project consists of the following project areas:

- **Digital Orthoimagery**
  - *0.25-foot Orthoimagery*
    - Microsoft UltraCAM Eagle with 100mm lens in non-restricted airspace and 210mm lens in restricted airspace.
    - 0.25-foot (3-inch) pixel resolution - 4-Band Digital Orthoimagery

        - 448 sq. mi.

    - *0.50-foot Orthoimagery*
        - Microsoft UltraCAM Eagle with 100mm lens
        - 0.50-foot (6-inch) pixel resolution - 4-Band Digital Orthoimagery
        - 7,075 sq. mi.

- **0.5-meter LiDAR**
    - Leica ALS70 Airborne LiDAR with USGS v.1 Specifications
    - 1,676 sq. mi.

- **2' Digital Contours**
    - 2-foot contours – NMAS standards
    - 591 sq. mi.

Pilot Area

The pilot area is +/- 2 square miles located within the project area. Woolpert and NCTCOG will determine the appropriate LUT and color balance for the entire 2015 project using the pilot data. 0.25 foot and 0.50' products will be submitted for review. The pilot area will be within The Colony, Texas.

Project Datum

The horizontal datum used for this project will be the North American Datum 1983 (NAD83), Texas State Plane Coordinate System, North Central Zone, and expressed in U.S. Survey Feet. The vertical datum used for this survey will be North American Vertical Datum 1988 (NAVD88).

Accuracy

- **Digital Orthoimagery**

  All photogrammetric mapping products will meet or exceed ASPRS Class I Accuracy Standards for 1" = 50' scale mapping (3-inch orthoimagery) and 1" = 100' scale mapping (6-inch orthoimagery)

- **0.5-meter LiDAR**
  0.5-meter LiDAR data will have 9.25 cm vertical accuracy based on USGS v.1 specifications. The final surface will be capable of supporting 2-foot interval contour generation. **LiDAR within the restricted airspace will hold an accuracy of 11.25cm, due to the increased flying height. If Woolpert is granted approval to acquire the LiDAR data at a lower altitude, the accuracy in the restricted airspace will improve.**

- **2' Digital Contours**
  The vertical accuracy for the 2' contours will be +/- 1.0' and meet National Map Accuracy Standards (NMAS) – 90% accuracy.

Schedule

The project will be initiated in January 2015 and will be completed on or before in September, 2015. Below are the production milestones established for this project:

The project will be initiated in December 2014 and will be completed on the following milestone dates.

Orthoimagery

Task Name	Duration	Start	Finish
Project Planning	20 days	Mon 12/1/14	Fri 12/26/14
Aerial Image Acquisition	42 days	Fri 1/2/15	Mon 3/2/15
Ground Control	10 days	Mon 1/5/15	Fri 1/16/15
Aerial Triangulation/Image Processing	40 days	Mon 2/2/15	Fri 3/27/15
Pilot (3" and 6")	13 days	Mon 3/30/15	Wed 4/15/15
NCTCOG Pilot Review	2 days	Thu 4/16/15	Fri 4/17/15
Digital Orthoimagery Production	65 days	Mon 4/20/15	Fri 7/17/15
True Orthos	35 days	Mon 4/20/15	Fri 6/5/15
WOOLPERT QA/QC	5 days	Mon 7/20/15	Fri 7/24/15
NCTCOG Review Block 1	5 days	Mon 7/27/15	Fri 7/31/15
NCTCOG Review Block 2	5 days	Mon 8/3/15	Fri 8/7/15
NCTCOG Review Block 3	5 days	Mon 8/10/15	Fri 8/14/15
SmartView fixes	10 days	Mon 8/17/15	Fri 8/28/15
Final Delivery			Mon 8/30/15

LiDAR

Task Name	Duration	Start	Finish
Project Planning	20 days	Mon 12/1/14	Fri 12/26/14
Ground Control	10 days	Fri 1/2/15	Thu 1/15/15
LiDAR Data Acquisition	11 days	Mon 1/19/15	Mon 2/2/15
LiDAR Data Processing	43 days	Mon 2/2/15	Wed 4/1/15
Hydrographic Flattening and Data Products	19 days	Mon 4/6/15	Thu 4/30/15
NCTCOG Review	5 days	Mon 5/4/15	Fri 5/8/15
Corrections	5 days	Mon 5/11/15	Fri 5/15/15
Final Delivery			Fri 5/30/15

Contours

Task Name	Duration	Start	Finish
3D Compilation	50 days	Wed 4/1/15	Tue 6/9/15
Cartography	70 days	Mon 5/11/15	Fri 8/14/15
Client Review	10 days	Mon 8/17/15	Fri 8/28/15
Corrections	10 days	Fri 8/28/15	Thu 9/10/15
Final Delivery			Wed 9/30/15

2. PROJECT WORKPLAN

DELTEK PHASE 90—GROUND CONTROL – (GORRONDONA & ASSOCIATES)
PHASE MANAGER: SCOTT DUNHAM

DESCRIPTION

Gorrondona & Associates will perform the ground control for the orthoimagery.

The Woolpert Survey Team directed by Scott Dunham will perform the following:

- Provide a control diagram
- Obtain 82 new horizontal and vertical PIDs (in addition to 2013 and 2014 control) for Orthoimagery
- Obtain a sufficient number of PIDs to meet the LiDAR accuracy requirements
- Obtain 30 check shots for LiDAR
- Provide one copy of the Survey report – April 1, 2015

SURVEY AND PLANNING

In lieu of using existing ground control, Woolpert has directed Gorrondona & Associates to obtain 000 additional new control points. The new control points will be photo-identifiable points (PID) as often as possible. PID points are more environmentally friendly and avoid unnecessary public intrusion and interference in the community. PID points will be picked on clear, well-defined locations that are photo identifiable from the appropriate scale. The PID points will be semi-permanent such as an X etched in concrete, PK Nail, or 18" rebar with cap. New control points will be GPS observed and be consistent with second order horizontal and third order vertical. This control will be sufficient to meet the required accuracy necessary to support the subsequent orthoimagery datasets.

All survey points must be tied into the TxDOT VRS network, as performed in 2013, and 2014.

GROUND CONTROL POINTS

- **Orthoimagery**
  - 82 new PIDs (in addition to the 2013 and 2014 PIDs) will be collected by the survey team to support the accuracy of the orthoimagery across the region. Woolpert has evaluated the proposed flight plans and has determined that this number of total PIDs will yield the ASPRS Class I accuracy for orthoimagery product.
- **LiDAR**
  - A sufficient number of control points will be set to support the accuracy of the LiDAR.
  - 30 Check shots

Field crews will collect the ground control and QA/QC check points using GPS-based real-time kinematic (RTK) survey techniques. For an RTK survey, the ground crew uses a roving unit to receive radio-relayed corrected positional coordinates for all ground points from a GPS base unit set up over a survey control monument. The roving unit records precise location measurements with an error (σ) of ≤ 1.5 cm (0.6 in). Woolpert distribute the RTK ground check points (GCPs)

throughout the task order AOI. These points will be located on open, bare earth surfaces with a level slope to enable effective assessment of swath-to-swath reproducibility and absolute accuracy. The techniques for establishing all ground control points will be outlined in the final survey report, including the locations and position residuals of all GCPs used to evaluate the LiDAR data accuracy.

A total of 30 bare earth/open terrain check shots will be randomly placed within total 1,676 square mile LiDAR area.

The ground check points for the LiDAR AOI will provide a reliable assessment of the LiDAR surface model. These points will be carefully planned and selected within and equally distributed over the LiDAR project area. They will be located in open terrain, where there is a high probability that the sensor will have detected the ground surface, without influence from the surrounding vegetation. The "open terrain" checkpoints will be located on flat or uniformly sloping terrain and will be at least five (5) meters away from any breakline where there is a change in slope. The checkpoint accuracy shall satisfy a Local Network accuracy of 5-centimeters at the 95% confidence level. These check points will be sent directly to the USGS and not incorporated into Woolpert's LiDAR processing production. The most common land cover categories are (but not limited to): Bare Earth/Open Terrain, Urban, Tall Weeds/Crops, Brush Land and Trees, and Forested and Fully Grown.

DATUM

The horizontal datum used for this project will be the North American Datum 1983 (NAD83), Texas State Plane Coordinate System, North Central Zone, and expressed in U.S. Survey Feet. The vertical datum used for this survey will be North American Vertical Datum 1988 (NAVD88).

SURVEY REPORT

The Woolpert Team will provide a Survey report containing all the pertinent information required, such as control diagrams, point descriptions, photographs, log sheets, etc. The report will be consistent with reports submitted by Woolpert. April 1, 2015

CONTROL DIAGRAMS

A diagram will be added to this plan.

DELIVERABLES AND QUALITY STANDARDS

The Woolpert Survey team will deliver the following:

- Survey Report – April 1, 2015

The Woolpert Survey team will use the following accuracy standards:

- The ground control accuracy shall satisfy a Local Network accuracy of 5-centimeters at the 95% confidence level.
- New control points will be GPS observed and be consistent with second order horizontal and third order vertical accuracies as defined by the NGS. All control points will be tied to the Dallas/Fort Worth TxDOT VRS network.

DELTEK PHASE 01— AERIAL IMAGERY ACQUSITION
PHASE MANAGER: DANIEL BURKE

General Acquisition			
	Mapping Scale - If features are to be collected/extracted from imagery		
	Requested Photography Scale		
6", 3"	Imagery Pixel resolution - Final Product(s)		
	Other- Specify:		
Digital Camera Specifications		**LiDAR Specifications**	
	Bands Required:		Required Post Spacing:
x	Color		Required Field of View (FOV):
x	CIR		Required Overlap:
x	4-Band		
x	300m Buffer past tile boundary		
Film Specifications		**MISC Specifications**	
	Black and White		Other- Specify:
	Color		
	CIR		
	Other- Specify:		

DESCRIPTION

For 2015 Woolpert will obtain the aerial imagery. Woolpert will be responsible for the image processing and overall project requirements.

Woolpert Aerial Imagery Team

The Woolpert Aerial Imagery Team directed by Greg Fox will perform the following:

- Obtain new R,G,B,NIR aerial photography at 3-inch and 6-inch.
- Develop a preliminary and final flight map/control diagram of the project
- Perform any re-flights required to meet the image specifications
- Incorporate Texas CORS stations and set ABGPS stations for the new aerial imagery
- Flight crews will provide image data to the processing department
- Provide the final diagram in shapefile format of the mosaic coverage's indicating dates of acquisition for each flight
- Provide one copy of the Aerial Photography report – April 1, 2015

The Woolpert team will provide aerial image acquisition services that encompass these steps:

- Image Acquisition Planning and Preparation
- Aerial Imagery Acquisition
- Reflights
- Optional Resolutions
- Image Specifications
- Aerial Photography Report
- Flight Diagrams
- Deliverables and Standards

IMAGE ACQUISITION PLANNING AND PREPARATION

For 2015, WOOLPERT will be obtaining new 0.25-foot and 0.50-foot 4-band imagery (R, G, B, and NIR) project wide (see Attachment D). The imagery will be acquired using the Microsoft UltraCAM with 100mm lens camera (0.25-foot and 0.50-foot). All imagery will be captured at a flying height to produce 0.25-foot and 0.50-foot pixel resolution imagery. **In the restricted airspace, WOOLPERT will use the Microsoft UltraCAM with 210mm lens to achieve the image specifications consistent with the non-restricted areas.**

The aerial imagery will be captured to produce orthoimagery at 1" = 50' scale with a 3-inch pixel resolution and 1" = 100' scale with a 6-inch pixel resolution.

WOOLPERT's goal is to capture imagery at a lesser resolution than the final output of 3-inch and 6-inch pixel resolution so that no resampling is necessary. The WOOLPERT team will acquire 6-inch pixel resolution in the restricted area, using the appropriate frame based camera and lens combination.

WOOLPERT will conference with the FAA at Dallas Fort Worth (DFW) International Airport and with **NCTCOG** to go over project logistics with FAA, prior the start of project.

AERIAL IMAGERY ACQUISITION

All imagery will be collected during the winter / early-Spring flying season (early January to late February) during leaf-off conditions for deciduous vegetation in the NCTCOG region. The sun angle shall be 30-degrees or greater, and streams should be within their normal banks, unless otherwise negotiated. Woolpert will submit the flight logs to NCTCOG as part of our acquisition documentation as confirmation of the actual flight date and time. During flight planning and acquisition, a significant effort is made to limit clouds, snow, fog, haze, smoke, or other ground obscuring conditions in the imagery. In no case will the maximum cloud cover exceed 5% per image. Within the immediate areas of power plants or factories, some steam or smoke and/or shadows may be visible on imagery.

Woolpert will provide a flight line diagram for the project area. Woolpert will make every attempt to capture the appropriate project area each flying season, however weather and ground conditions may influence our ability to accomplish the task in its entirety. Woolpert will provide daily weather reports during the acquisition phase of the project. Together Woolpert and NCTCOG will determine the appropriate action if the aerial acquisition task cannot be completed within the window of opportunity due to uncontrollable events such as weather or ground conditions.

ACCESS TO RESTRICTED AIRSPACE

Woolpert understands that NCTCOG the project area has one of the most challenging aerial acquisition environments in the country. Coordination with the FAA and ATC officials during the project kick off process and during the image acquisition will be vital to the success of this project. The Woolpert team has been granted access to the Bravo Airspace and will fly at an altitude of 8500 feet MSL to adhere to the minimum flight height imposed by the DFW ATC.

REFLIGHTS

Woolpert will run the raw UltraCAM imagery data through an initial process immediately after acquisition has been completed to ensure that all program specifications have been met. This allows any necessary re-flights to be accomplished as soon as possible after the date of the original acquisition.

IMAGE SPECIFICATIONS

The following are the image specifications and guidelines:

3-inch Resolution

- Output Resolution—3-inch
- Flying Altitude— 9,900-feet AGL (210mm focal length lens)
- Forward Lap—60% across the project area
- Side Lap—30 % across the project area
- Ground Conditions—free from snow, haze, fog, or dust; when streams are within their normal banks;
- Sun Angle—greater than 30 degrees
- Atmospheric Moisture—less than 5% cloud cover
- Tip—will average one-degree or less, Tilt—will average one-degree or less, and Crab—will average three-degrees or less on the project area
- Building Lean—supplemental flights
- Tone, Brightness, Contrast—provide various image samples for approval prior to full production

6-inch Resolution

- Output Resolution—6-inch
- Flying Altitude— 9500-feet AGL (100mm focal length lens)
- Forward Lap—60% across the project area
- Side Lap—30 % across the project area
- Ground Conditions—free from snow, haze, fog, or dust; when streams are within their normal banks;
- Sun Angle—greater than 30 degrees
- Atmospheric Moisture—less than 5% cloud cover
- Tip—will average one-degree or less, Tilt—will average one-degree or less, and Crab—will average three-degrees or less on the project area
- Building Lean—supplemental flights
- Tone, Brightness, Contrast—provide various image samples for approval prior to full production

PRELIMINARY (UN-RECTIFIED) IMAGES

Woolpert will provide preliminary imagery within two weeks after acquisition allows NCTCOG to view and utilize new imagery for applications that can be performed with un-rectified imagery, while the digital orthoimagery is being produced.

AERIAL PHOTOGRAPHY REPORT

Woolpert will provide an Aerial Photography report containing all the pertinent information required such as –flight maps, Flight log, aircraft, weather log, ABGPS, etc.

DELIVERABLES AND QUALITY STANDARDS

Woolpert will deliver the following:

- Aerial Photography Report – April 1, 2015

- ESRI shapefiles of both planned (navigation) and actual (ABGPS) flight lines. The actual flight lines will be provided as mosaicked coverage's and contain attribute information showing date, start, and end times information.

The aerial imagery will be able to produce orthoimagery meeting the following horizontal accuracies: ASPRS for 1" =50' scale and ASPRS for 1" =100' scale

- 3-inch pixel +/- 0.5 RMSE
- 6-inch pixel +/- 1.0 RMSE

Functionality of flight to include the ability to extract layers of data, when combined with LiDARgrammetry mapping techniques to produce optional future products:

- Planimetric features: roads, parking, rivers, lakes, vegetation, etc.
- Topographic features: DTM, 2-foot Contours, etc.

DELTEK PHASE 02— LIDAR DATA ACQUSITION
PHASE MANAGER: GREG FOX

General Acquisition			
	Mapping Scale - If features are to be collected/extracted from imagery		
	Requested Photography Scale		
	Imagery Pixel resolution - Final Product(s)		
	Other- Specify:		
Digital Camera Specifications		**LiDAR Specifications**	
	Bands Required:	x	Required Post Spacing: 0.5-meter
	Color	x	Required Field of View (FOV): +/-14
	CIR	x	
	4-Band		
	300m Buffer past tile boundary		300m Buffer past tile boundary
Film Specifications		**MISC Specifications**	
	Black and White		Other- Specify:
	Color		
	CIR		
	Other- Specify:		

DESCRIPTION

For 2015 Woolpert will obtain 0.5-meter LiDAR data for a non-contiguous area totaling 1,561 square miles. All LiDAR will be captured using Woolpert's Leica ALS70 Airborne LiDAR sensors and will conform to USGS v.1 Specifications.

NPS ≤ 0.500 m, or point density **≥ 4 points per m2** for first-return data. Spatial distribution of points must be uniform and free from clustering. 90% of cells in a 1-meter grid will contain at least four (4) LiDAR points.

100 meter buffer surrounding the AOI is required for flight planning and acquisition, with no buffer needed in between tiles. Buffer will not be included in final delivery.

Leaf-off and no significant snow cover or flood conditions, unless approved by TWDB. Must be cloud, smoke, dust and fog-free between the aircraft and ground.

0.5-Meter Average GSD

- Point Density..... 0.5–meter average
- Flying Height.....6,500 AGL
- Scan Angle..... ±14-degrees
- Swath Width .....2,992 feet

Woolpert owns and operates three Cessna 404 aircraft configured with two Leica ALS70-HP LiDAR systems and one Optech Gemini ALTM LiDAR system. These systems are capable of measurement rates 500 kHz and recording up to five returns per laser pulse. (Note: The first three returns will record an associated intensity value. If a fourth return is captured the system will not record an associated intensity value.)

Woolpert will create a flight plan to maximize the capability of our LiDAR systems and will obtain data at a nominal pulse spacing (NPS) of 0.50 meters (Although this is the requirement, we plan to collect this data at 4 points per meter). The new LiDAR data will be obtained for the multiple AOIs consisting of point number, X coordinate, Y coordinate and Z coordinate, along with an intensity value.

The flight plan will be developed to take advantage of the AOI geometry to minimize flight time and costs while maintaining high accuracy of the acquired data.

For quality assurance purposes, the LiDAR data is processed immediately after the acquisition to verify the coverage has no voids. Accompanying GPS data will be post processed using differential and Kalman filter algorithms to derive a best estimate of trajectory. The quality of the solution is verified to be consistent with the accuracy requirements of the task order. Any required reflights will be scheduled at the earliest opportunity.

Weekly acquisition reports will be provided as shape files and uploaded to the project website. The flight lines will be attributed with the date of acquisition.

Woolpert LiDAR Data Acquisition Team

The Woolpert Aerial Imagery Team directed by Greg Fox will perform the following:

- Obtain new 0.5-meter LiDAR
- Develop a preliminary and final flight map/control diagram of the project
- Perform any re-flights required to meet the image specifications
- Incorporate Texas CORS stations and set ABGPS stations for the new LiDAR
- Flight crews will provide LiDAR data to the processing department
- Provide the final diagram in shapefile format of the LiDAR coverages indicating dates of acquisition for each flight
- Provide one copy of the LiDAR acquisition report – April 1, 2015

Woolpert will obtain LiDAR data for each AOI, including a minimum buffer of at least 100 meters. If flight clearances are required, we are familiar with the Federal Aviation Administration's procedures for obtaining flight clearances.

Airborne GPS Processing: In this process, kinematic corrections for the aircraft position are resolved using aircraft GPS and static ground GPS (1-Hz) for each geodetic control (base station) within the task order limits.

IMU Processing: Post processing of the IMU system data is completed to compute an optimally accurate blended navigation solution based on Kalman filtering technology, or the best estimate of trajectory (BET). Typical accuracy achieved through post-processing is less than 0.01 degrees for pitch and roll, and better than 0.03 degrees for heading.

Lidar Point Cloud Processing: When the calibration, data acquisition, and GPS and IMU processing phases are complete, the formal data reduction process will commence as follows:

- Calculate laser point position by associating SBET position to each laser point return time, scan angle, intensity, etc. The raw laser point cloud data is created for the entire survey in *.las (ASPRS v1.2) format; each point will maintain the corresponding scan angle, return number (echo), intensity, and x, y, z information.
- Test relative accuracy using ground classified points per each flight line. We will perform automated line-to-line calibrations for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift. Calibrations will be performed on

ground classified points from paired flight lines. Every flight line will be used for relative accuracy calibration.

- Classify ground and non-ground points. Assess statistical absolute accuracy via direct comparisons of ground classified points to ground RTK survey data. Convert data to orthometric elevations and appropriate map projection.
- Create ground models (DEMs) as triangulated surfaces and export as ERDAS .img grids at the specified pixel resolution.

The bare earth LiDAR points will undergo additional QA/QC steps to verify that artifacts have been removed. Using the bare earth points determined during the classification, Woolpert will develop a Digital Elevation Model (DEM).

Breakline Compilation Along Water Bodies: This task requires hydrologic flattening of the LiDAR data. Breaklines defining water bodies and streams will be compiled. The breaklines will be used to perform the hydrologic flattening of water bodies, and the gradient hydrologic flattening of double line streams. Lakes, reservoirs and ponds, at a nominal minimum size of two (2) acres or greater (~350' feet in diameter for a round pond), will be compiled as closed polygons. The closed water bodies will be collected at a constant elevation. Rivers, creeks, and streams, at a nominal minimum width of 30.5 meters (100-feet), will be compiled in the direction of flow, with both sides of the stream maintaining an equal gradient elevation. Woolpert proposes the following steps to perform the hydrologic flattening of water bodies.

1. Woolpert will use the LiDAR bare-earth data and LiDAR intensity imagery produced as part of this task order.
2. We will utilize an integrated software approach to combine the LiDAR data and 2D breaklines. This process “drapes” the 2D breaklines onto the 3D LiDAR surface model to assign an elevation. A monotonic process is performed to ensure the streams are consistently flowing in a gradient manner. A secondary step within the program verifies an equally matching elevation of both stream edges. The breaklines that characterize the closed water bodies are draped onto the 3D LiDAR surface and assigned a constant elevation at or just below ground elevation.
3. Lakes, reservoirs and ponds, at a minimum size of 2-acres or greater, will be compiled as closed polygons. During the collection of line work, the technical staff will use a program that displays the polygon measurement area as a reference to identify lakes larger than 2-acres. Breaklines defining rivers and streams, at a nominal minimum width of 30.5 meters (100 feet), will be draped with both sides of the stream maintaining an equal gradient elevation. All ground points will be reclassified from inside the hydrologic feature polygons to water, class nine (9).
4. All ground points will be reclassified from within a 1.5 meter (5 foot) buffer along the hydrologic feature breaklines to buffered ground, class ten (10).
5. The LiDAR ground points and hydrologic feature breaklines will be used to generate a new digital elevation model (DEM).
6. TerraScan will be used to add the hydrologic breakline vertices and export the lattice models.
7. The new hydrologically flattened DEM will be delivered in 32-bit floating point raster ERDAS
8. .IMG format at a 1 meter pixel, based upon the 1,000 meters x 1,000 meters tiles in the UTM Zone 13, NAD83 projection and NAVD88 meters using the geoid model of 2012 (GEOID12A).
9. The hydrologic breaklines compiled as part of the flattening process will be provided to the USGS as an ESRI shapefile. The breaklines defining the water bodies greater than 2-acres will be provided as a PolygonZ file. The breaklines compiled for the gradient flattening of all rivers and streams at a nominal minimum width of 30.5 meters (100 feet) will be provided as a PolylineZ file.

Tile Layout: The LiDAR data will be provided in the 2000' x 3000' orthoimagery tiling scheme. To reduce file size for each LiDAR tile, Woolpert will divide each tile into 4 tiles as shown below. The tile names will be tilename_1, tilename_2, etc.

1	2
4	3

DELTEK PHASE 03—LIDAR DATA PROCESSING
PHASE MANAGER: MICHAEL MEISER

DESCRIPTION

Provide LiDAR data processing and quality control to meet accuracy requirements as defined in the Project Specific Instructions and/or the Statement of Work.

ROLES AND RESPONSIBILITIES

Lidar Processing Lead – Michael Meiser will be responsible for scheduling LiDAR processing services, allocating and supervising staff, monitoring hourly budgets and schedule, and communicating with the project manager and other task lead.

TASK SUMMARY

For quality assurance purposes, the LiDAR data is processed immediately after the acquisition to verify the density and that the coverage has no voids. The **nominal pulse spacing** (NPS) shall be no greater than 0.50 meters, assessment to be made against a single swath of first returns. **Data voids** > 7.84 meters [areas => $(4*NPS)^2$ measured using 1st-returns only] within a single swath are not acceptable except:

- Where caused by water bodies.
- Where caused by areas of low near infrared reflectivity such as asphalt or composition roofing.
- Where appropriately filled in by another swath.

Accompanying GPS and IMU data will be post processed and the quality of the solution will be verified to be consistent with the accuracy requirements of this task order. All required reflights will be scheduled at the earliest opportunity.

LiDAR Data Accuracy Requirements

- **Data Accuracy:** Data collected under this Task Order shall meet the National Standard for Spatial Database Accuracy (NSSDA) accuracy standards. The NSSDA standards specify that vertical accuracy be reported at the 95 percent confidence level for data tested by an independent source of higher accuracy. For example the metadata statement shall read, "Tested __ (meters, feet) vertical accuracy at 95 percent confidence level."

- **The Fundamental Vertical Accuracy (FVA)**: 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 9.25 cm in the "open terrain" land cover category (11.25 cm in Bravo Restricted Airspace areas). This is a required accuracy.
- **Point Cloud and Bare Earth Data:** The point cloud data will be classified and delivered with the following format requirements:

- **Point Cloud Data** shall consist of a minimum of first, last, and at least one intermediate return.

- **Point Cloud Data** shall contain at a minimum:
    - X, Y, and Z coordinates.
    - Intensity values.

- GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each return.

- **Point Cloud Data** shall be delivered in a single LAS 1.2 format file, one file for each deliverable tile.

- **Point Cloud Data** shall be classified according to ASPRS Classification standards, used by TNRIS.

  - Classifications shall include:
    - Class 1. Unclassified
    - Class 2. Bare-earth Ground
    - Class 3. Low Vegetation
    - Class 4. Medium Vegetation
    - Class 5. High Vegetation
    - Class 6. Building
    - Class 7. Low Point (noise)
    - Class 9. Water
    - Class 13. Bridges/Culverts

Bare Earth Surface (Raster DEM): A digital elevation mode (DEM) shall be created and delivered for each delivery tile, with the following specifications:

- To be delivered in 32-bit floating point raster, ERDAS .IMG format.
- DEM shall be created from the bare earth surface model created during the post processing of the raw point cloud data.
- DEM elevations shall in meters, to two decimal values.
- DEM post positions will be clipped to the appropriate tile formats. The DEM grid shall be at a resolution of one (1) meters.
- DEMs will be hydrologically flattened.
- Void areas, such as areas outside the task order AOI boundary, but within the tiling scheme will be coded using a unique "NODATA" value. This value will be identified in the appropriate location within the file header.
- Data Source Date: The data source date for the DEMs shall be the latest date that LiDAR data is acquired for the given tile.
- Georeference information shall be included in each raster file.

Digital Surface Model (DSM)**:** A first return DSM will be generated to the limits of the Buffered Project Area; however, the accuracy requirements will only be applied to the data within the Defined Project Area. The DSM will be produced with the following specifications:

- To be delivered in 32-bit floating point raster, ERDAS .IMG format.
- DSM elevations shall in meters, to two decimal values.
- DSM post positions will be clipped to the appropriate tile formats. The DEM grid shall be at a resolution of one (1) meters.
- Void areas, such as areas outside the task order AOI boundary, but within the tiling scheme will be coded using a unique "NODATA" value. This value will be identified in the appropriate location within the file header.
- Data Source Date: The data source date for the DEMs shall be the latest date that LiDAR data is acquired for the given tile.
- Georeference information shall be included in each raster file.

Tile Layout: The LiDAR data will be provided in the 2000' x 3000' orthoimagery tiling scheme. To reduce file size for each LiDAR tile, Woolpert will divide each tile into 4 tiles as shown below. The tile names will be tilename_1, tilename_2, etc.

1	2
4	3

Metadata: Task order level metadata for each data product and lift describing the LiDAR production process shall be submitted as a deliverable. Tile level metadata is not required for this task order.

Federal Geographic Data Committee (FGDC) compliant metadata shall be provided in extensible markup language (.xml) format for the project. The required LiDAR metadata fields, for FGDC compliant metadata, shall include at a minimum:

- Date(s) of LiDAR data acquisition.
- Geoid used to reduce satellite derived elevations to orthometric heights.
- Nominal Pulse density.
- How GPS coordinates were referenced.
- Maximum and mean differential baseline lengths.
- Calibration procedures, not including proprietary LiDAR data calibration processes.
- Attributes present in the data set (e.g. X, Y, Z, intensity, all with numbers of significant figures specified).
- Processing steps
- Positional accuracy including validation of:
- The point data (absolute, within swath, and between swaths).
- The bare earth surface (absolute).
- Other optional deliverables as appropriate.
- Attribution schema description

RISK MANAGEMENT

No significant risk expected assuming processing and quality control procedures are followed.

QUALITY ASSURANCE

Woolpert will be tasked with the Quality Assurance for this project.

DELIVERABLES

- Weekly acquisition reports will be provided as shape files. The flight lines will be attributed with the date of acquisition.
- A final flight line shape file that is attributed with the date of acquisition.
- One digital copy of the ground control and QA/QC points in shape file format.
- One PDF digital copy of the Ground Control Report.
- One PDF digital copy of the Project Report.
- One file per swath, one swath per file, with file size not to exceed 2GB. Long swaths (those which result in a LAS file larger than 2GB) shall be split into segments. Each segment will thenceforth be regarded as a unique swath. Georeference information will be included in the LAS header.
- Classified LiDAR data (all returns point clouds) in LAS 1.2 format. Georeference information will be included in the LAS header.

- One set of one (1) meter pixel raster Digital Surface Models (DSM) in 32-bit floating point raster, ERDAS .IMG format.
- One set of one (1) meter pixel raster Digital Elevation Models (DEMs) of the bare-earth surface in 32-bit floating point raster, ERDAS .IMG format. Not to include bridges and overpass structures in the bare earth model.
- The hydrologic breaklines compiled as part of the flattening process will be provided as a shapefile deliverable. The breaklines defining the water bodies greater than two (2) acres will be provided as a Polygon Z file. The breaklines compiled for the gradient flattening of all rivers, creeks and streams at a nominal minimum width of 30.5 meters (100-feet) will be provided as a Polyline Z file.
- One set of 8-bit gray scale intensity images, clipped to match the reference tiling scheme.
- Task order and product level FGDC compliant metadata in XML format.
- One set of the data for each Delivery Lot will be provided on external hard drives.

DELTEK PHASE 04—HYDROGRAPHIC FLATTENING AND DATA PRODUCTS
PHASE MANAGER: MICHAEL MEISER

In order to achieve hydrologic flattening of the LiDAR data, Woolpert will perform the following:

- Breaklines will be used to perform the hydrologic flattening of water bodies, and the gradient hydrologic flattening of double line streams. Lakes, reservoirs and ponds, at a nominal minimum size of two (2) acres or greater (~350' feet in diameter for a round pond), will be compiled as closed polygons. The closed water bodies will be collected at a constant elevation. Islands larger than two (2) acres will also be collected.
- Breaklines for rivers, creeks, and streams, with a nominal minimum width of 50-feet, will be compiled in the direction of flow, with both sides of the stream maintaining an equal gradient elevation. Any breakline/hydro feature created during the hydro-flattening process will be delivered in ESRI format.
- Points within the water feature will be reclassified as level 9; points within the buffer will be reclassified as level 10. Rivers will be 3-D polylines. Water bodies and Islands will be 3D polygons. The shapefile will contain attributes uniquely identifying type as Rivers, Waters bodies, and Islands.

QA/QC of Hydro-Flattened Data

Initial QA/QC for this project will be performed in Global Mapper v11, by reviewing the grids and hydrologic breakline features. Edits and corrections are addressed individually by tile. If a water body breakline needs to be adjusted to improve the flattening of the ArcGRID DEM, the area will be cross referenced by tile number, corrected and a new ArcGRID DEM will be regenerated and reviewed in Global Mapper.

DELTEK PHASE 05—IMAGE PROCESSING/AT
PHASE MANAGER: RAVEN MCDAVID

IMAGE PROCESSING

Image Rectification

Woolpert will match the existing DEM data to a photo image through Z/I ImageStation software to create a digital orthoimage. The relevant DEM data will be merged with the orientation parameters and the new digital imagery. A complete differential rectification is carried out with a set of algorithms that remove image displacement due to topographic relief and the tip and tilt of the aircraft at the moment of exposure. Rectification will be done as a batch process. Rectification blocks will be based upon the image acquisition blocks. The resulting digital orthoimages will be 3-inch and 6-inch primary pixel resolution, with accurate X,Y ground coordinates, and RGBN scale values from 0 to 255.

Mosaicking and Radiometry

Woolpert will use Orthovista and ZI OrthoPro software for tone balancing and image mosaicking. The digital orthophotography will be seamless and have uniform, balanced color. Tiles will be mosaicked so the images appear to be completely seamless, except at mosaic lines on bodies of water. Special attention will be given to the placement of mosaic lines in developed areas so as not to bi-sect buildings, bridges or other man-made structures not at ground level. Woolpert image specialists will take special care around bridges and overpasses to correct excessive distortion. Bridges and overpasses will not appear to be warped or skewed. Overpasses/bridges along roadways shall retain location and geometry. Radiometric adjustment will include color balancing, overall tone adjustment and brightness and contrast enhancements of the imagery over the entire project.

Image Aesthetics

As part of the image processing procedure, Woolpert will provide a minimum of three different image data sets. Woolpert's image specialist will prepare each data set with various color balance, tone, density, contrast, and brightness qualities. Woolpert will meet with NCTCOG to determine the appropriate image sample to be used as a guideline for the pilot project. During the review of the pilot further refinement of the image settings may take place before implementing full production.

AERIAL TRIANGULATION

Woolpert will utilize softcopy aerial triangulation techniques for the extension and densification of ground control.

Woolpert will provide an aerial triangulation report that contains a narrative of the analytical triangulation results, descriptions of equipment, procedures, and computer software used. Root-mean-square (RMS) error summaries will be given for misclosures at control points. It will also include any problems (including misfits at control points) that arose during the aerial triangulation and how they were resolved.

DELTEK PHASE 06—DIGITAL ORTHOIMAGERY
PHASE MANAGER: DOUG JOOS

Ortho Deliverables			
Tile Information:		**Deliverable Pixel Specifications:**	
x	Tile Size: 2,000' X 3,000	x	0.075m (0.25')
x	Naming Convention: **NCTCOG standard**	x	0.15m (0.5')
	Deliver Partial Tiles at project boundary		1'
x	Deliver Full Tiles touching project boundary		0.60m (2-foot)
	Other– Specify:		Other- Specify:
Deliverable Format:		**Fill Color for Partial Tiles**	
x	Tiff/Tiff World file		Black
x	GeoTiff		White
	ECW – ER Mapper image		Other- Specify:
	Other- Specify:	x	Full Tiles only
		MISC Deliverables:	
MrSID Compression		x	Ortho Report: Pdf and hard-copy
x	Compression Ratio:18:1	x	Shapefile of Flight lines
	Per County/AOI	x	Shapefile of Mosaicked Seamlines
x	Per Tile	x	Shapefile of Tile Index
			Metadata: Per Tile
		x	Metadata: Per Deliverable Product
			Other- Specify:

Woolpert will produce new 8-bit, 4-band stacked color digital orthoimagery at 0.25-foot (3-inch) pixel resolution and 0.5-foot (6-inch), with accurate X, Y ground coordinates, and RGBN scale values from 0 to 255.

The Woolpert Orthoimagery Team directed by Doug Joos will perform the following:

- NCTCOG will provide digital files containing bridge locations and building footprints to assist in the orthoimagery production.
- Use the existing DEM data for orthoimagery rectification.
- Use the new 4-band 3-inch and 6-inch pixel resolution aerial imagery
- Use the NCTCOG existing tile grid (2,000' X 3,000')
- Imagery contrast, brightness, and tone will be matched before any mosaicking can be initiated. Use an automated/ interactive methodology to perform image mosaicking. Mosaick vector line data will be delivered.
- Using the bridge file as a guide, review imagery and modify any imagery that does not meet the required specification.

- Once the imagery has passed the review process, using the appropriate grid tile the individual tile will be extracted and the data will be provided to the cartography department to be QA/QC'd and installed onto the project website.

ORTHOIMAGERY TILES AND FORMATS

The orthoimage tiling format will follow a modular layout, with each 1"=50' scale image and 1"=100' scale image covering 2,000' x 3,000' and named according to the NCTCOG naming convention. Orthophoto tiles will be clipped to eliminate overlap between adjacent tiles. Woolpert will use an interactive mosaicking process for tone balancing and image mosaicking. Full tiles will be used within the project interior and full tiles will be used along the exterior perimeter.

VALIDATION AND ORTHOIMAGERY QA/QC

Each digital orthoimage will be checked and corrected to ensure a proper and consistent tone, as well as density, contrast, and brightness qualities. Each image will be checked on the screen at the intended output scale for image defects or other blemishes. Each digital orthoimage will be checked for accuracy on screen. All control points and test points that are visible on the aerial photography are visited on screen and the X, Y coordinates are displayed. This information is cross-referenced with the X, Y information provided by the ground survey. In addition, each orthoimage will be checked against adjacent images at the tile boundaries to ensure that there are no displacement errors.

The empty tiles will need to be white, 255.

DELIVERABLES AND QUALITY STANDARDS

The Woolpert Orthoimagery team will deliver the following:

- One set of 4-band stacked digital orthoimagery at 0.25-foot (3-inch) pixel resolution for each tile in GeoTIFF format with TIFF world files
- One set of 4-band stacked digital orthoimagery at 0.5-foot (6-inch) pixel resolution for each tile in GeoTIFF format with TIFF world files.
- ESRI 10.1 shapefile of flightlines with acquisition dates
- ESRI 10.1 shapefile of control points
- ESRI 10.1 shapefile of tile index
- ESRI 10.1 shapefile of mosaicked seamlines
- Each deliverable product will include FGDC metadata

The Woolpert Orthoimagery team will use the following accuracy standards:

The orthoimagery will meet the following horizontal accuracies:

- 0.5-foot (3-inch) Pixel Resolution (ASPRS Class I) ±0.5-feet RMSE
- 1.0-foot (6-inch) Pixel Resolution (ASPRS Class I) ±1.0-feet RMSE

DELTEK PHASE 91— TRUE ORTHOS (BHI)
PHASE MANAGER: SCOTT DUNHAM

WOOLPERT will produce true orthos in areas with buildings exceeding 60 stories located in the following central business districts (See Attachment B):

- Dallas CBD
- Fort Worth CBD
- IH-635/I-75 intersection
- Dallas North Tollway corridor from IH-635 to Keller Springs Parkway

The true ortho boundaries will be the same four used on the 2013 NCTCOG orthoimagery project, as referred in "Attachment D". WOOLPERT will employ the same true ortho work flow used on the 2013 orthoimagery project.

Orthophotos are geometrically corrected for displacement due to relief. A DEM of the surface is used to rectify the imagery. However, vertical features will appear as "leaning". True orthophotos add the dimension of correcting for the distortion of buildings, eliminating building lean.

This method involves the use of input images and a digital surface model (DSM) containing both the bare-earth terrain model (DEM) with an additional 3-D component of building features (Digital Building Model – DBM).

The basic steps of true orthoimage generation include: Use existing, updated, or generate new 3D building features from LiDAR or manual 3-D compilation. DSM (bare earth and DBM) -based true orthophoto generation, shadow removal, and occlusion (image voids) refilling from multi-orthophotos, and the merging of the generated orthophoto into the base image data set. 60% sidelap is typically used to support the occlusion refilling.

DELTEK PHASE 07—CONTOURS-COMPLIATION
PHASE MANAGER: BRIAN FOSTER

Woolpert will utilize the new 0.5-meter LiDAR data and interactive breakline compilation using SUMMIT Evolution DAT/EM software. The combination of LiDAR and stereo breaklines can meet or exceed NMAS vertical accuracies for 2-foot (1.0' RMSE) contours generated from the DTM using the TerraSolid family of software. All contours will contain an elevation attribute that will hold the photogrammetrically obtained elevation.

Woolpert's combined process for creating a DTM maximizes the benefits of software capabilities for quality control and streamlines the entire process.

- **Initial Contours.** Contours are generated from the classified bare-earth LiDAR points. These contours are then superimposed over the imagery and QA/QC'ed for accuracy.

- **Breaklines.** 3D breaklines will be added where the initial contours, generated from LiDAR alone, do not meet specifications. Some examples of areas that may need to be supplemented by breaklines include; natural slope breaks such as ditches, tops and bottoms of embankments, etc; and constructed slope breaks such as roads and graded areas.

- **Spot Elevations.** Optional

- **LiDAR.** Once the breaklines have been collected, the bare earth LiDAR points will be filtered to remove points that have been superseded by the 3D breaklines. The LiDAR can then be used, along with the breaklines, to generate final contours.

Photogrammetric Mapping QA/QC. The evaluation of a DEM/DTM is performed at several stages in the production process as either a standard ISO9001-2000 process requirement or to meet project specific requirements. This evaluation is performed to ensure that all elevation data meets or exceeds the required accuracy for this phase of the project. This QA/QC procedure is performed both at the digital photogrammetric softcopy workstation and at a digital editing workstation.

DELTEK PHASE 08—CONTOURS-CARTOGRAPHY
PHASE MANAGER: BRIAN FOSTER

The Woolpert team has numerous years of cartographic experience, both in traditional hardcopy and digital techniques, and it is equipped with state-of-the-art digital cartographic workstations. Cartography is responsible for data translations, conversions, editing, processing, and final QA/QC of spatial information. At the onset of any project, the cartography department will design and implement custom quality control (QC) software and tracking forms for use throughout the entire production phase.

The quality review of our digital geospatial data development processes invokes numerous methodologies designed to ensure that products meet project requirements and specifications. Our teams regularly use peer-review cycles, specialized on-line QC evaluation tools as well as intermediate and final data delivery inspection.

DELTEK PHASE 09— SMARTVIEW CONNECT AND PROJECT WEBSITE
PHASE MANAGER: JONATHAN DOWNEY

SMARTVIEW CONNECT

Woolpert offers a streamlined QA/QC tracking application known as SmartView™ Connect (SVC). SmartView™ Connect is an Open Geospatial Consortium (OGC) compliant imagery service that allows internet viewing access to all project deliverables while the project is underway. SVC is a website that is built and maintained by Woolpert and is used by current clients performing preliminary imagery and QC processes. It will preclude the need, cost, and time consumed for the preparing and shipping of draft data products from Woolpert the NCTCOG.

Upon Woolpert completing the QA/QC of the aerial imagery, within one week our staff will publish preliminary imagery and alert the relevant parties that the imagery is available to the NCTCOG.

Immediately preceding the creation of the orthoimagery deliverables, our staff will publish the data to SmartView™ Connect and alert the relevant parties that the data is ready for review. NCTCOG and its partners will then log onto the site and immediately access the orthoimagery via a web browser. All that is necessary is a web browser that supports Adobe Flash.

The main advantage of using this system, other than the time and cost savings, is that SVC has tools for collecting issues and managing those issues all the way through to the resolution process. In the event that NCTCOG and its partner's staff encounter an issue in the data while browsing the site, they will be able to interactively markup the issue on the screen using the tools available within SVC.

Because each member of the NCTCOG and its partners reviewing team will be granted a username to access the site, each issue created will be stored and tracked within the system and the Woolpert team will immediately respond to that issue.

Once all issues have been reported to Woolpert, we will work diligently to resolve each and every one. Upon completion of the issue resolution phase of the project, Woolpert will create an issue resolution report and post the final, revised data to the SVC website. After Woolpert and NCTCOG are satisfied that all issues and concerns have been addressed, Woolpert will package the final orthophotography for delivery. This final delivery will also contain a geodatabase of all issues, along with the history of each issue, to serve as a permanent record of what was reported to Woolpert, what fixes were made, and who accepted the final imagery.

PROJECT WEBSITE

Woolpert will maintain a secure project website to help communicate various aspects of the project to authorized participants. Any project documentation distributed will be available on the project website, including:

- Progress reports
- Meeting minutes
- Final scope of services
- Project schedule

Other contract documentation such as terms and conditions, and contract addendums

One of the most important components of the project website will be reporting progress of the project. We've found this most effectively presented graphically with maps of the project area. For example, maps could be presented showing the following information:

- Flight schedule
- Status of completed flights
- Area delivery schedule
- Status of delivery areas – color coded according to the current status of each area, or portion of the area.
- Completed and accepted delivery areas

The Project Website would be password protected allowing NCTCOG to control the access to the information.

DELTEK PHASE 10— WMS
PHASE MANAGER: JONATHAN DOWNEY

SMARTVIEW CONNECT WMS

As an extension of SmartView™ Connect, WOOLPERT will provide NCTCOG with access to SmartView Connect WMS, our high-performance, OGC Compliant Web Mapping Service (WMS Server) that has been custom developed to work with the exact same data we use to support the SVC QA/QC process above. Within moments of the final approval of the orthophotography, WMS access will be enabled and NCTCOG will be able to consume the data and provide data to users via the web. This service will be available for one year beyond project delivery. If the period extends beyond one year, NCTCOG and Woolpert will negotiate a storage price.

DELTEK PHASE 80 — QA/QC MANAGEMENT/DELIVERY
PHASE MANAGER: JOE CANTZ

Woolpert understands the NCTCOG will be directing the QA/QC effort and each entity will be performing their own individual QA/QC of data. NCTCOG will provide a QA/QC tool and provide direction and guidance on QA/QC procedures and protocol.

NCTCOG and each entity have ten (10) business days to review each deliverable and submit review comments. Woolpert will review each comment with NCTCOG to determine the appropriate action.

DELTEK PHASE 98— PROJECT MANAGEMENT
PHASE MANAGER: SCOTT DUNHAM

DESCRIPTION

Scott Dunham, CP will serve as Woolpert's Project Manager for NCTCOG's 2014 Digital Orthophotography Project.

Scott Dunham will be responsible for the following:

- **Development of the Project Plan.** The project plan is a dynamic document that contains the procedures and documentation on the workflow necessary to meet the final contract specifications.
- **Production of all photogrammetric services as specified in the final contract.** Woolpert will be responsible for the quality, accuracy, and timeliness of all products and services.
- **Maintaining quality control and quality assurance throughout the production cycle to the final products.** Woolpert will implement our ISO 9001:2000 procedures, which are a set of defined and certificated operational guidelines.
- **Delivery of all pilot and final products according to schedule and final contract.** Woolpert will meet with NCTCOG to develop a schedule that works best for all clients involved.
- **Maintaining security of NCTCOG's source material.** Woolpert will not only maintaining security of the Counties' source material, but also of all data products acquired and produced through this contract.
- **Identify and disclose any unusual circumstances or issues with datasets.** Woolpert's Project Manager will be in constant contact with NCTCOG's representative(s). Through various forms of communications, Woolpert's PM will communicate any issues or problems to NCTCOG immediately and identify possible solutions to them.
- **Meetings/Briefing Sessions and Reports.** The Woolpert Project Manager will hold bi-weekly Project team meetings. Both internal Woolpert Team meetings and meetings with NCTCOG will be documented with significant decisions and information entered into meeting minutes. Action items will be assigned for follow-up and will be tracked until completed. The results of the follow-up will be recorded and made part of the Project record.

KICKOFF MEETING

A minimum of three briefing sessions will occur face-to-face with NCTCOG representatives. Woolpert will also hold monthly phone conference calls to maintain client communication. The typical number and content are as follows:

Kick Off Meeting and Project Plan Review (1) – January 2015
Pilot Project Delivery and Review (1)
Project Status (1 or as needed)
Project Wrap Up (1)

Scott Dunham will tailor the project plan for presentation during a kickoff meeting, which will occur first with Woolpert's production members and then with NCTCOG. An important element of these meetings is the assignment of roles and responsibilities among team members and the client.

After the project manager meets with our production staff, Woolpert will conduct a kickoff meeting with NCTCOG assigned project personnel. In addition to reviewing the negotiated scope of services and roles and responsibilities of team members, the following project components will be identified:

- Any required safety plans (i.e. during survey activities – road/traffic management)
- The required frequency, content, and distribution plan for progress reporting
- Preferred method and frequency of communication between Woolpert and NCTCOG (such as telephone, fax, project website, email, and face-to-face visits)

PROJECT PLAN

Woolpert will meet with NCTCOG representatives to formalize the scope of services into a project plan. During the planning phase, Woolpert will develop a project plan that covers the phases of the project, detailing how to achieve the desired results. Based closely on the negotiated Scope of Services in the contract, this plan will be a step-by-step guide for completing the project. This formal planning phase helps ensure that the final deliverables not only meet the technical specifications outlined in the Request for Proposal, but also the functional needs anticipated by NCTCOG, who will depend on the imagery and related data developed during the project.

PROJECT LOG AND CONFLICT PREVENTION

The Project Manager will be keeping a “Project Issues Log”. This is a tool that will allow for a practical method to manage this project by listing key project issues. Everyone knows that almost every project is bound to face issues and problems. Our goal is to identify all those key issues as they happen and list them down in the issue log. Prioritize the issues (using Important and Urgent matrix) and assign the owners with specific deadlines to address them.

TRANSMITTALS

The PM will prepare each transmittal accompanying delivery to the client. Internal deliveries to and from Woolpert offices will be prepared by the appropriate task leaders. All shipments must have a transmittal.

PROGRESS REPORTS, TASK, AND INVOICING

The PM will provide written progress reports and invoices the first of each month. Invoices will be based upon percent complete per task. IOT will issue task orders under the master contract. The task orders will be addendum to the master contract. The following task will be set-up for each year of the contract:

- Project Planning
- Imagery Acquisition
- Ground Control
- Aerial Triangulation
- Orthoimagery

Any additional task will be handled through a contract addendum and added to the project plan.

3. SCHEDULE

The project will be initiated in January 2014 and will be completed on the following milestone dates.

Orthoimagery

Task Name	Duration	Start	Finish
Project Planning	20 days	Mon 12/1/14	Fri 12/26/14
Aerial Image Acquisition	42 days	Fri 1/2/15	Mon 3/2/15
Ground Control	10 days	Mon 1/5/15	Fri 1/16/15
Aerial Triangulation/Image Processing	40 days	Mon 2/2/15	Fri 3/27/15
Pilot (3" and 6")	13 days	Mon 3/30/15	Wed 4/15/15
NCTCOG Pilot Review	2 days	Thu 4/16/15	Fri 4/17/15
Digital Orthoimagery Production	65 days	Mon 4/20/15	Fri 7/17/15
True Orthos	35 days	Mon 4/20/15	Fri 6/5/15
WOOLPERT QA/QC	5 days	Mon 7/20/15	Fri 7/24/15
NCTCOG Review Block 1	5 days	Mon 7/27/15	Fri 7/31/15
NCTCOG Review Block 2	5 days	Mon 8/3/15	Fri 8/7/15
NCTCOG Review Block 3	5 days	Mon 8/10/15	Fri 8/14/15
SmartView fixes	10 days	Mon 8/17/15	Fri 8/28/15
Final Delivery			Mon 8/30/15

LiDAR

Task Name	Duration	Start	Finish
Project Planning	20 days	Mon 12/1/14	Fri 12/26/14
Ground Control	10 days	Fri 1/2/15	Thu 1/15/15
LiDAR Data Acquisition	11 days	Mon 1/19/15	Mon 2/2/15
LiDAR Data Processing	43 days	Mon 2/2/15	Wed 4/1/15
Hydrographic Flattening and Data Products	19 days	Mon 4/6/15	Thu 4/30/15
NCTCOG Review	5 days	Mon 5/4/15	Fri 5/8/15
Corrections	5 days	Mon 5/11/15	Fri 5/15/15
Final Delivery			Fri 5/30/15

Contours

Task Name	Duration	Start	Finish
3D Compilation	50 days	Wed 4/1/15	Tue 6/9/15
Cartography	70 days	Mon 5/11/15	Fri 8/14/15
Client Review	10 days	Mon 8/17/15	Fri 8/28/15
Corrections	10 days	Fri 8/28/15	Thu 9/10/15
Final Delivery			Wed 9/30/15

4. DELIVERABLES

Woolpert will provide the following:

ORTHOIMAGERY

- One hard copy of the Project Plan and one electronic copy in PDF file format
- One hard copy of the Aerial Image Acquisition Flight Plan and Control Diagram, and one
- digital copy in shape file format
- One hard copy of the Aerial Image Acquisition report and one electronic copy of the
- report in the PDF file format
- One hard copy of the Survey report and one electronic copy of the report in the PDF file format
- One hard copy of the Aerial Triangulation report, and one digital copy in shape file format
- SmartView Connect On-Line QA/QC Tool
- One set of preliminary unrectified images served on SmartView Connect
- One set of 1"=50' scale color digital ortho imagery at 0.25-foot pixel resolution for each ortho tile in GeoTIFF format (for 3-inch AOI)
- One set of 1"=100' scale color digital ortho imagery at 0.5-foot pixel resolution for each ortho tile in GeoTIFF format (for 6-inch AOI)
- MrSID Generation 2 and 4 at an agreed on compression (after final acceptance)
- SmartView™ Connect WMS web mapping service
- FGDC Compliant Metadata
- Data will be delivered on an external hard drive

Deliverable Acceptance

The client has thirty (30) days to review each deliverable and submit review comments. Woolpert will review each comment and together with the client determine the appropriate action. If it is determined that Woolpert needs to re-submit a deliverable or portion of a deliverable, that deliverable or portion will be completed and resubmitted within thirty (30) business days after the appropriate action has been determined. Any deliverable not submitted by the Client for review within ninety (90) days will be deemed as accepted; therefore Woolpert will not be obligated to change, correct, or resubmit that deliverable.

LIDAR

- Weekly acquisition reports will be provided as shape files. The flight lines will be attributed with the date of acquisition.
- A final flight line shape file that is attributed with the date of acquisition.
- One digital copy of the ground control and QA/QC points in shape file format.
- One PDF digital copy of the Ground Control Report.
- One PDF digital copy of the Project Report.
- Classified LiDAR data (all returns point clouds) in LAS 1.2 format. Georeference information will be included in the LAS header.
- LiDAR data in ascii format, x,y,z
- One set of one (1) meter pixel raster Digital Surface Models (DSM) in 32-bit floating point raster, ERDAS .IMG format.

- One set of one (1) meter pixel raster Digital Elevation Models (DEMs) of the bare-earth surface in 32-bit floating point raster, ERDAS .IMG format. Not to include bridges and overpass structures in the bare earth model.
- The hydrologic breaklines compiled as part of the flattening process will be provided as a shapefile deliverable. The breaklines defining the water bodies greater than two (2) acres will be provided as a Polygon Z file. The breaklines compiled for the gradient flattening of all rivers, creeks and streams at a nominal minimum width of 30.5 meters (100-feet) will be provided as a Polyline Z file.
- One set of 8-bit gray scale intensity images, clipped to match the reference tiling scheme.
- Task order and product level FGDC compliant metadata in XML format.
- One set of the data for each Delivery Lot will be provided on external hard drives.

5. COMPENSATION

The fee for services is a lump sum fee. Woolpert will provide progress reports and invoices monthly. Invoices will be based upon percent complete and are to be paid within 30 days after receipt.

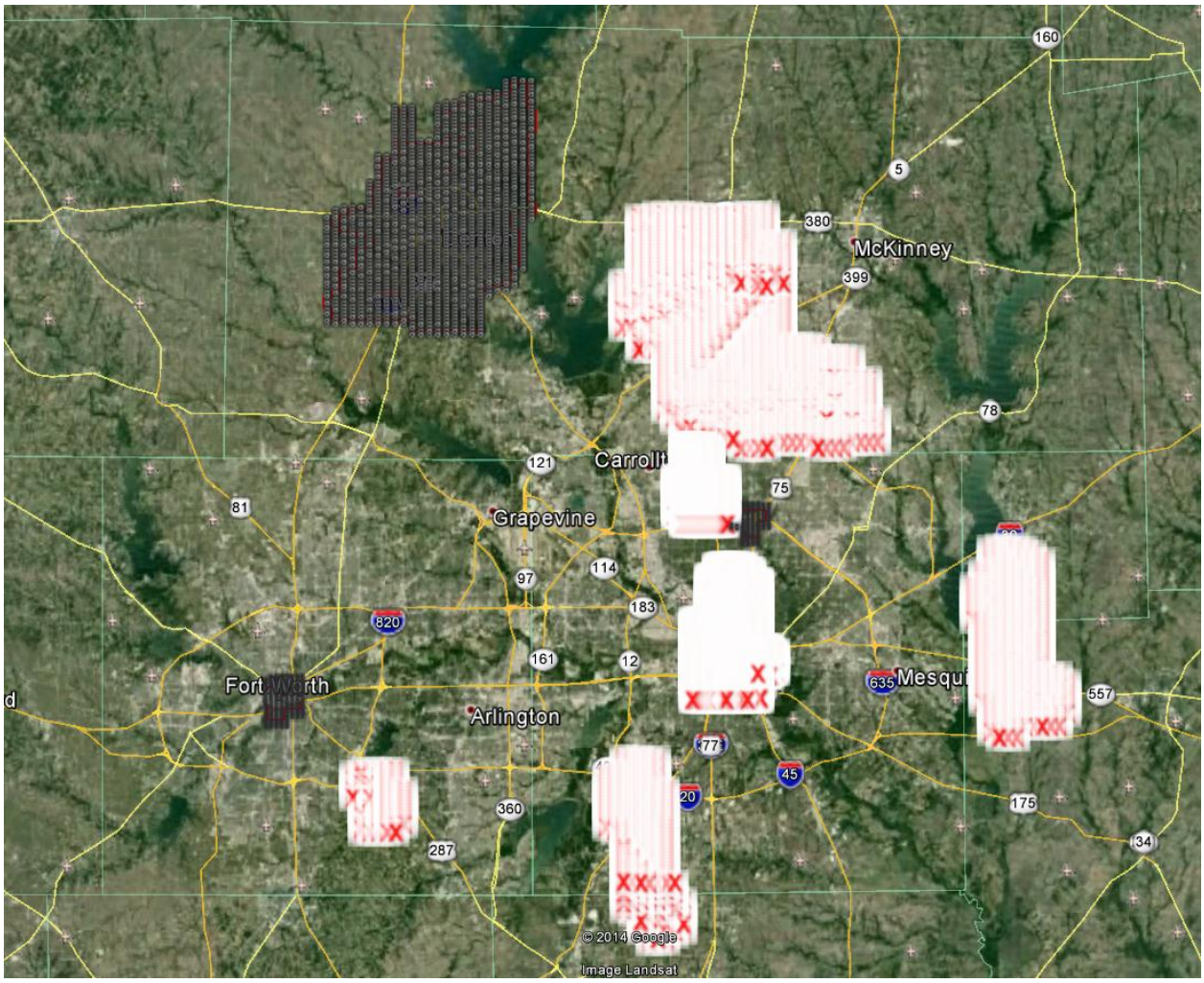
Invoicing will be based upon the following task orders:

1. Project Plan $10,000.00
2. Imagery/LiDAR Acquisition $475,000.00
3. Ground Control $110,000.00
4. Aerial Triangulation $100,000.00
5. Orthoimagery $353,555.00
6. LiDAR $170,000.00
7. Contours $192,000.00

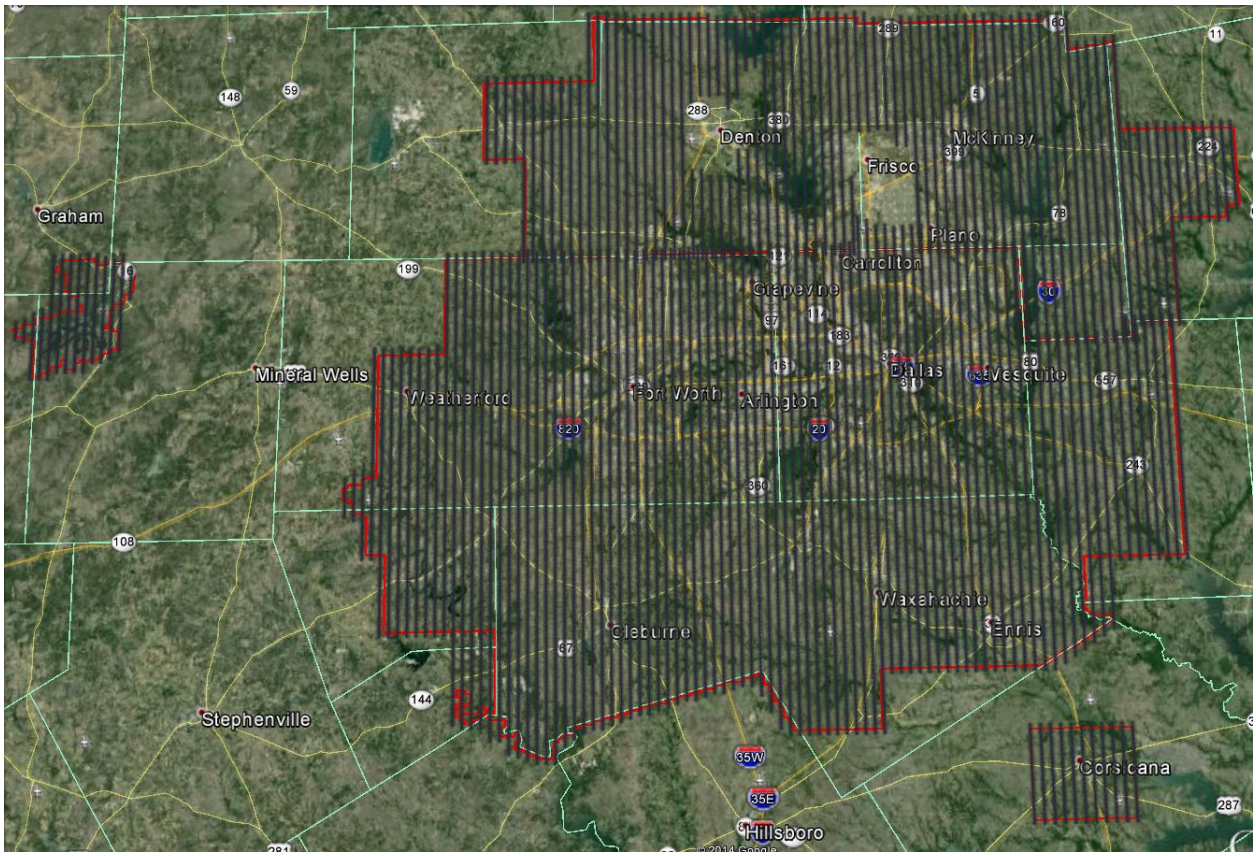
Total Lump Sum Fee $1,410,555

ATTACHMENT "A" ORTHOIMAGERY/LIDAR FLIGHT MAPS

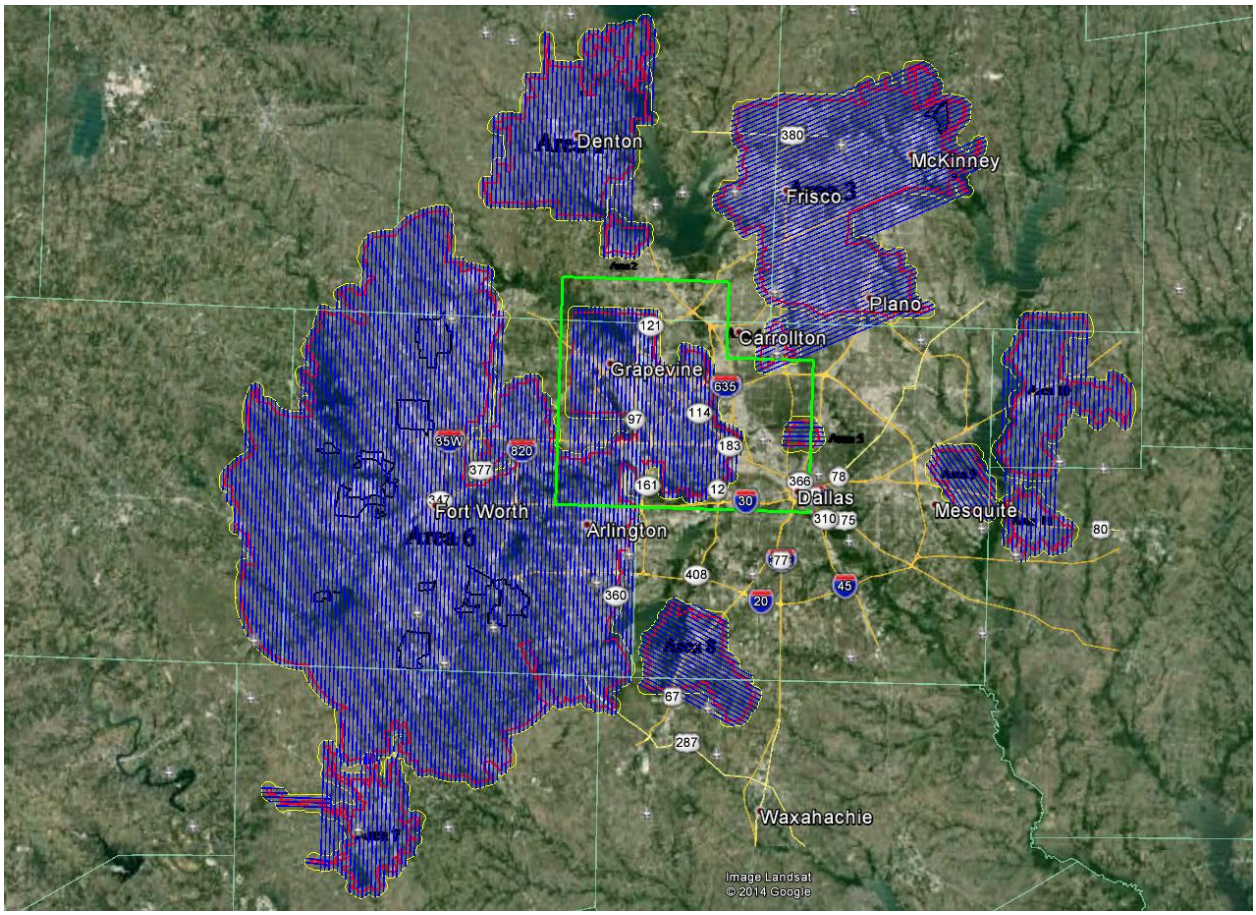
0.25-FOOT ORTHOIMAGERY



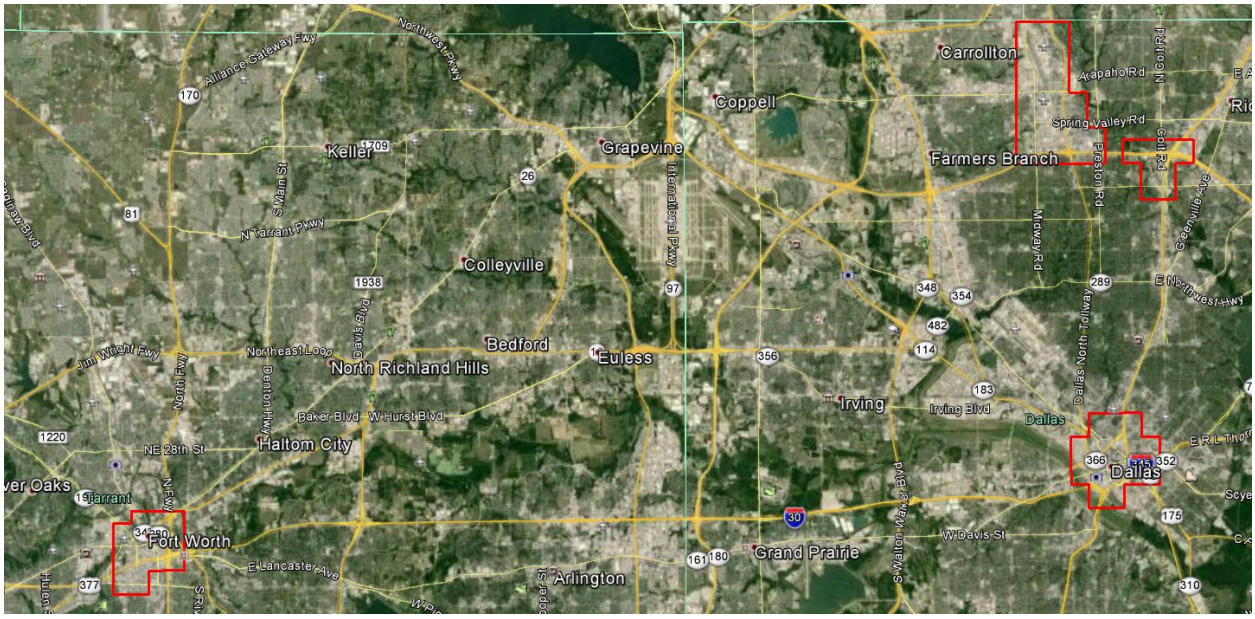
0.50-FOOT ORTHOIMAGERY



0.5-METER LIDAR



TRUE ORTHO AOI



CONTOURS AOI