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December 19, 2017

Kelly Jo Hoffmann, P.E., S.E.
Capital Programs, Engineer Planner
University of Illinois
Facilities & Services
1501 S Oak Street
Champaign, IL 61820

RE: LiDAR 2018 - Data Acquisition and Processing for Boone and Winnebago Counties in Illinois
(U180##)

Dear Ms. Hoffman,

The following constitutes our revised proposal for *Professional Services* on the above referenced project.

Project Understanding:

1. Overview:

It is a pleasure for Merrick & Company ("Merrick") to provide the University of Illinois at Urbana-Champaign ("UIUC") with proposal to perform Professional Services supporting the Illinois Height Modernization Program ("ILHMP"), which is managed by the Illinois State Geological Survey ("ISGS"). The required Professional Services include the acquisition and processing of high fidelity Light Detection and Ranging (LiDAR) data for Boone and Winnebago Counties commencing in the Spring of 2018. The area that comprises Boone and Winnebago Counties is approximately 860 square miles. Services include LiDAR acquisition; ground control survey; LiDAR post-processing; LiDAR classification; hydro-flattening; QA/QC, and; development of derivative deliverable products (including metadata and reporting). Further details of these services are described below.

2. Project Design Team:

The following table includes Key Personnel aligned with project role and corporate title as presented in the previously submitted (and approved) *Upside Input Worksheet*:

Name	Role	Position Title/Function/Company
Jacoby Douglas E	Project Manager / GSS Practice Lead	1CA - Sr. Project Manager - 1
Bethel Matthew S	Director of Operations and Technology	4DA - Support Manager II - 1
Adey Bruce A	Production Manager	4MG - GSS Supervisor II - 1
Paton Allen M	Geospatial Analyst	4QM - GSS Specialist - 1
Lobato Merinda	LiDAR Project Coordinator	4QM - GSS Specialist - 3
Pierson David Q	Senior Photogrammetrist	4UO - Senior GSS Analyst - 1
Beck Joshua C	Senior Geomatics Consultant	4UO - Senior GSS Analyst - 8
Johnston Jr Sanford L	QA/QC Administrator	4UO - Senior GSS Analyst - 9
Stangel Peter	Field Operator	4WS - Field Operator II - 1

3. Budget:

Project budget is To Be Determined (TBD). There is no construction. All LiDAR vendors' proposals are all LUMP SUM; not hourly.

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4. Schedule:

Merrick proposes the following production schedule:

Task Name	Start	Finish
Work Order / Notice to Proceed Issued from UIUC		2/23/2018
Survey Control / LiDAR Checkpoints*	2/26/2018	3/30/2018
LIDAR Acquisition*	2/26/2018	3/30/2018
LIDAR Post-processing (Laser, IMU, GNSS) / LiDAR Calibration	3/5/2018	4/27/2018
Pilot Project		
LIDAR Classification	4/30/2018	5/11/2018
Breakline Collection	5/14/2018	5/18/2018
Deliverable(s) Preparation and QA/QC	5/21/2018	6/1/2018
Submittal of Deliverable Products		6/1/2018
ISGS Review and Acceptance	6/4/2018	6/22/2018
Boone County		
LIDAR Classification	6/25/2018	7/20/2018
Breakline Collection	7/23/2018	8/10/2018
Deliverable(s) Preparation	8/13/2018	8/24/2018
Deliverable(s) Preparation and QA/QC		8/24/2018
ISGS Review and Acceptance	8/27/2018	9/21/2018
Winnebago County		
LIDAR Classification	8/27/2018	9/21/2018
Breakline Collection	9/24/2018	10/19/2018
Deliverable(s) Preparation and QA/QC	10/22/2018	11/2/2018
Submittal of Deliverable Products		11/2/2018
ISGS Review and Acceptance	11/5/2018	11/30/2018

* Weather and site conditions permitting

Merrick is confident we can meet the final proposed deadline as stated should the LiDAR Acquisition is delayed past 3/30/18.

Bimonthly progress reports will be submitted to UIUC as required in accordance with the contract.

5. Documentation Reviewed:

Owner/Professional Services Consultant Agreement and Attachments,
University of Illinois Design Guidelines
[University of Illinois at Urbana-Champaign Facilities Standards](#)
[Capital Professional Services Scope and Fee Negotiation Policy](#)
[Capital Professional Services Consultant Error and Omissions Policy](#)

Project Submittal Requirements <http://www.fs.illinois.edu/docs/default-source/FIR/project-submittal-requirements.pdf>

- PART 4: GIS STANDARDS

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Project Program/Scope Statement

- RFP (Request For Proposal) documentation and instructions received via email from Ms. Kelly Jo Hoffman, dated Tuesday, November 28, 2017. Documents include:
 - 01 Professional Services Proposal Template 2017.11.14.docx
 - boone_winnebago_request_for_proposal.docx
 - Merrick_upside_input_V1.xlsx
 - PSAAttachmentD-MAFBECert.pdf
 - BooneWinn_TileIndex.zip inclusive of Esri shapefiles:
 - Boone_TileIndex
 - Winn_TileIndex

Other

- USGS-NGP LiDAR Base Specifications, Techniques and Methods 11–B4, Version 1.2, November 2014 (TM11-B4) (<http://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf>)
- ASPRS Positional Accuracy Standards for Digital Geospatial Data (EDITION 1, VERSION 1.0. - NOVEMBER, 2014) (http://www.asprs.org/a/society/committees/standards/ASPRS_Positional_Accuracy_Standards_Edition1_Version100_November2014.pdf)

Professional Services:

1. Basic Services:

Project Area

As required, Boone and Winnebago Counties are to be treated as independent stand-alone counties / project areas. The following outlines the quantities for each county:

- ❖ Winnebago County, IL
 - Full extent of Esri shapefile *Winn_TileIndex*
 - Approximately 554.55 square miles
 - 3,865 tiles formatted as 2,000' x 2,000'
- ❖ Boone County, IL
 - Full extent of Esri shapefile *Boone_TileIndex*
 - Approximately 303.03 square miles
 - 2,112 tiles formatted as 2,000' x 2,000'

That said, the Defined Project Area (DPA) for the AOIs covers approximately 857.58 square miles. See **Figure 1** for an illustration.

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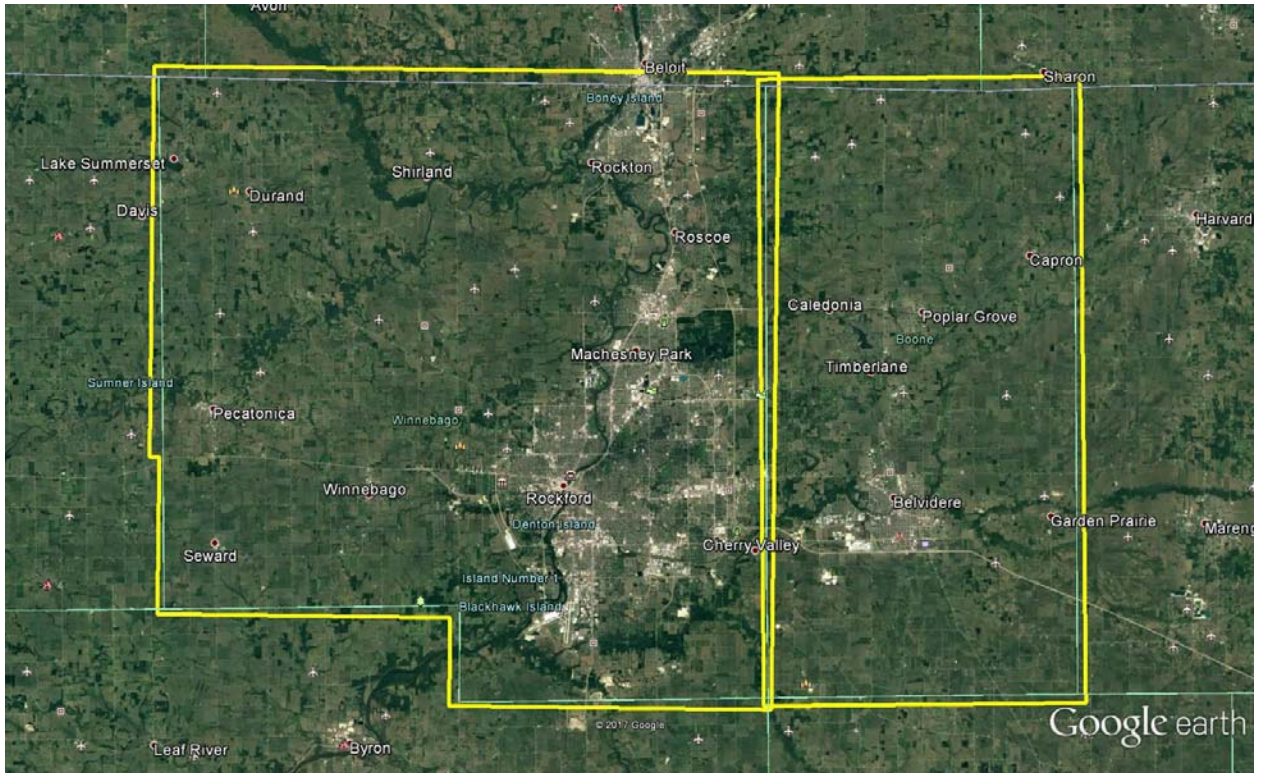


Figure 1

General Specifications and Requirements

Unless otherwise stated in the abovementioned RFP, the LiDAR mapping requirements and deliverables will meet the standards as outlined in the *USGS-NGP LiDAR Base Specifications, Techniques and Methods 11-B4, Version 1.2, November 2014* (TM11-B4) (<http://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf>). Quality Level Two (QL2) LiDAR specifications suggest an Aggregate Nominal Point Density (ANPD) of greater than or equal to two points per square meter ($\geq 2\text{ppsm}$), or less than or equal to seven-tenths of a meter ($\leq 0.71\text{m}$) Aggregate Nominal Point Spacing (ANPS).

Please note that ISGS is requiring Aggregate Nominal Point Density (ANPD) of greater than or equal to four points per square meter ($\geq 4\text{ppsm}$), or less than or equal to five-tenths of a meter ($\leq 0.50\text{m}$) Aggregate Nominal Point Spacing (ANPS). This requirement doubles the point density of standard QL2 LiDAR data.

Although the requested ANPD is greater than standard QL2 LiDAR, the relative and absolute accuracy requirements remain the same. These accuracy requirements are as follows:

- ❖ Relative Accuracy
 - $\leq 6\text{cm}$ Smooth surface repeatability
 - $\leq 8\text{cm}$ RMSD_z
 - $\pm 16\text{cm}$ maximum difference

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- ❖ Vertical Accuracy (absolute NVA [Non-vegetated Vertical Accuracy])
 - $\leq 10\text{cm RMSE}_z$
 - $\leq 19.6\text{cm}$ at the 95% confidence level (Accuracy_z)
 - Vegetated Vertical Accuracy (VVA) $\leq 29.4\text{cm}$ at the 95% percentile

To recap, Merrick agrees to the final LiDAR data will be delivered at the ANPD of ≥ 4 ppsm, and meet QL2 accuracy standards as stated in TM11-B4.

Data Acquisition (Collection)

LiDAR Acquisition

The Merrick will acquire the LiDAR point cloud using a utilizing an Optech Galaxy LiDAR sensor in a fixed-wing aircraft. The Galaxy is a high performance 550 kHz LiDAR sensor capable of collecting large areas efficiently. Merrick has planned for an acquisition area to include a one hundred-meter (100m) buffer to achieve the Buffered Project Area (BPA) per TM11-B4. See **Figure 2** for illustration of the proposed (preliminary) LiDAR flight plan.

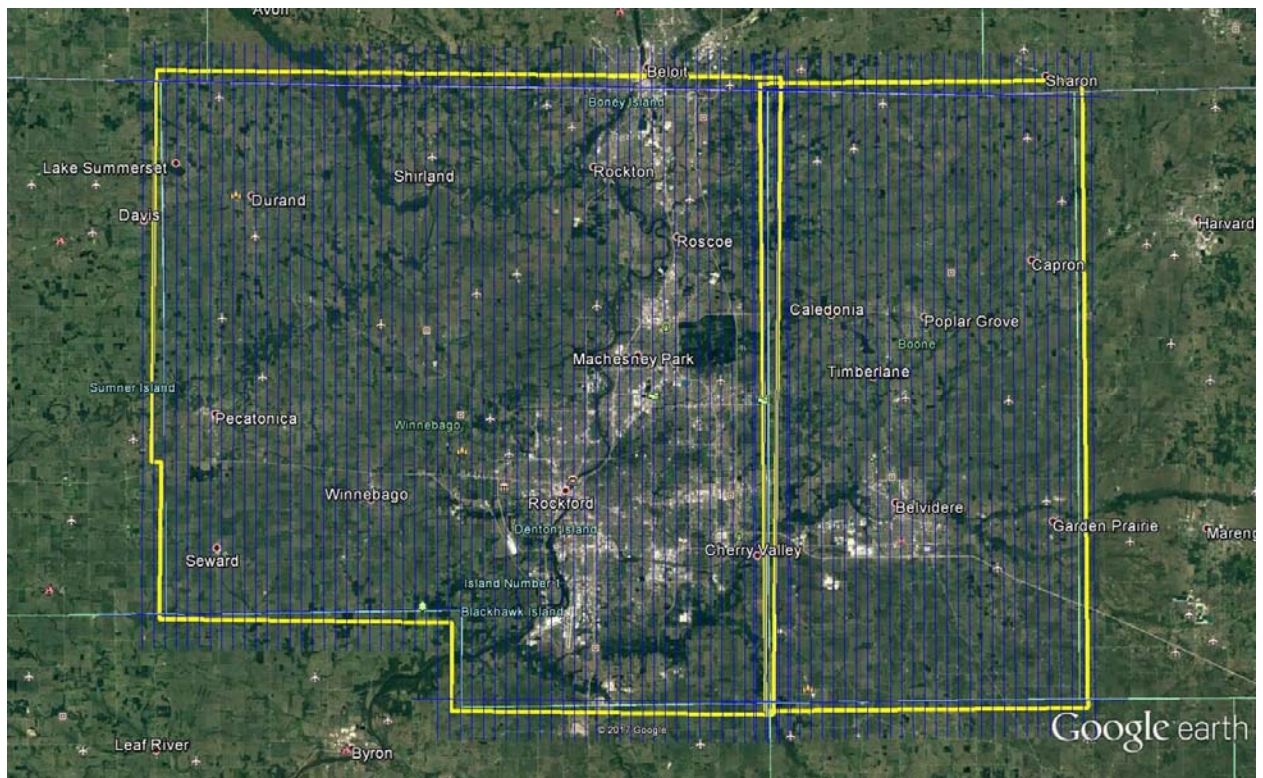


Figure 2

The following outlines important project-specific criteria used in the planning of the LiDAR collection:

- ❖ ≥ 4 ppsm ANPD (Aggregate Nominal Point Density)
 - $\leq 0.50\text{m}$ ANPS (Aggregate Nominal Point Spacing)

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- ❖ ≥20% sidelap / overlap
- ❖ ≤30° FOV (Field Of View)
 - ISGS is focused on vegetation penetration and sufficient overlap is ensure no data gaps between flight lines
- ❖ Pre-vegetation emergence (i.e., leaf-off)
- ❖ Cloud-free skies (including smoke- and haze-free)
- ❖ Water levels are at normal or low levels (i.e., non-flood levels)

Upon completion of the LiDAR acquisition, all point loud data is checked for coverage and quality. Any data gaps or suspect data is reflown immediately prior to demobilizing from the project site.

Control

Merrick will establish a total (minimum) of one hundred (100) LiDAR checkpoints, which will be used to validate the accuracy of the LiDAR point cloud. Of the 100 checkpoints, sixty (60) checkpoints will categorized as Non-vegetated Vertical Accuracy [NVA] checkpoints, and forty (40) will be of the Vegetated Vertical Accuracy [VVA] checkpoint variety. Theses represent the minimum standards as outlined in TM11-B4 / *ASPRS Positional Accuracy Standards for Digital Geospatial Data (EDITION 1, VERSION 1.0. - NOVEMBER, 2014)* (http://www.asprs.org/a/society/committees/standards/ASPRS_Positional_Accuracy_Standards_Edition1_Version100_November2014.pdf). The NVA and VVA checkpoints will be spatially distributed across the project area.

Additionally, Merrick will survey a smaller quantity of checkpoints (control) to be used independently to support the LiDAR calibration task. These control points are planned to total thirty (30). The following outlines the quantities for each county:

- ❖ Winnebago County, IL
 - 35 NVA checkpoints
 - 25 VVA checkpoints
 - 18 calibration control points
- ❖ Boone County, IL
 - 25 NVA checkpoints
 - 15 VVA checkpoints
 - 12 calibration control points

See **Figure 3** for illustration of the suggested LiDAR checkpoint / control locations.

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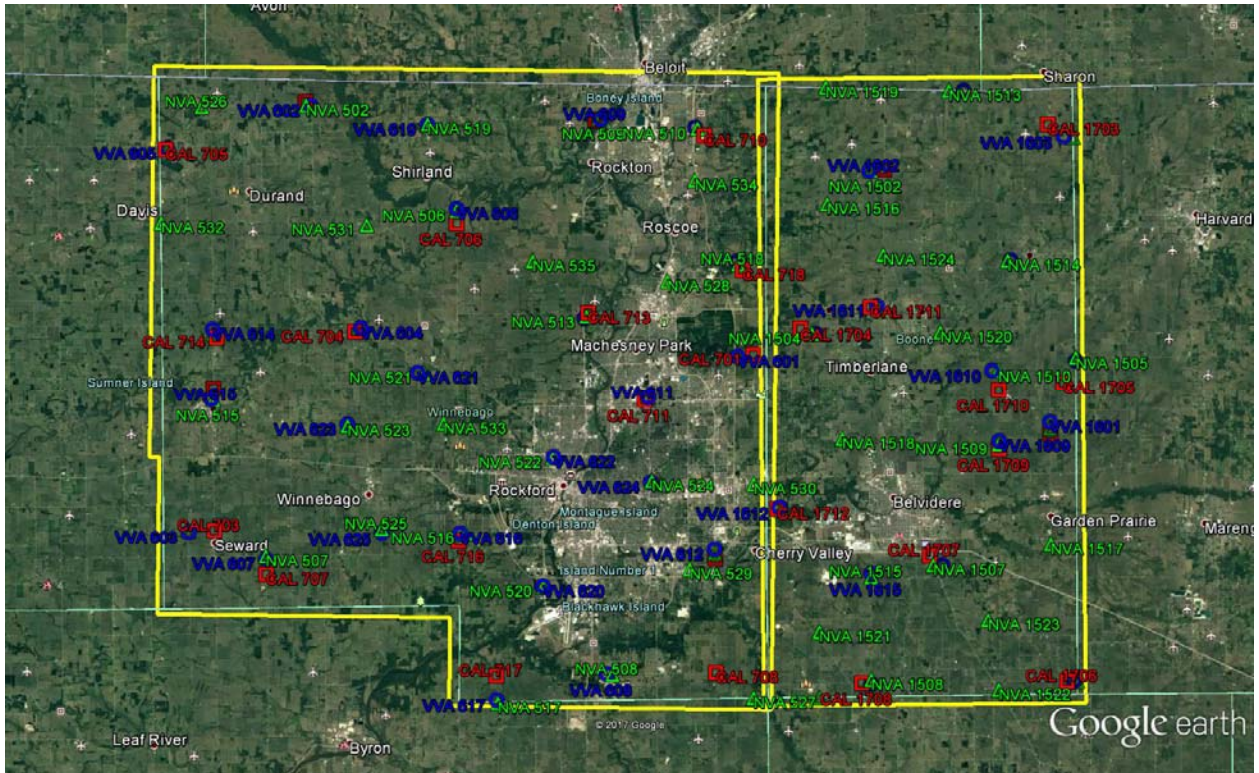


Figure 3

Merrick understands that all survey control including LiDAR checkpoints (and deliverable products) will be referenced as follows:

- ❖ **Projection** – Illinois State Plane Coordinate System, East Zone (Boone County) and West Zone (Winnebago County)
- ❖ **Horizontal Datum** - North American Datum of 1983 (NAD 83), National Adjustment of 2011 (NA2011) (epoch 2010.00)
- ❖ **Vertical Datum** – North American Vertical Datum of 1988 (NAVD 88); using the latest NGS-approved geoid (i.e., GEOID12B) for converting ellipsoid heights to orthometric elevations
- ❖ **Units** – U.S. Survey Foot

Juneau Associates, Inc., P.C. (“Juneau”) of Granite City, IL will be supporting Merrick for the required survey control tasks. Juneau is a VOSB (Veteran Owned Small Business).

Data Processing and Handling

LiDAR Post-processing and Calibration

Once all the LiDAR data is in-house, Merrick staff commences with the post-processing of the laser, Inertial Measurement Unit (IMU), and Global Navigation Satellite System (GNSS) data. This results in the trajectory / SBET (Smoothed Best Estimate of Trajectory) data required to perform the calibration. The calibration task focuses on achieving the relative accuracy. The relative accuracy targets (previously stated) are as follows:

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- ❖ ≤6cm Smooth surface repeatability
- ❖ ≤8cm RMSD_z
- ❖ ±16cm maximum difference

LiDAR Classification

Once these relative accuracy statistics are confirmed, Merrick moves into the LiDAR classification phase. At this point Merrick performs a series of automated and semi-automated filtering algorithms to arrive at the following ASPRS LAS 1.4 formatted LiDAR classes:

- ❖ Class 1 = Unclassified
- ❖ Class 2 = Bare-earth Ground
- ❖ Class 3 = Low Vegetation [0.5-5 feet]
- ❖ Class 4 = Medium Vegetation [5-20 feet]
- ❖ Class 5 = High Vegetation [>20 feet]
- ❖ Class 6 = Buildings
- ❖ Class 7 = Low point (noise)
- ❖ Class 9 = Water
- ❖ Class 10 = Ignored ground (breakline proximity)
- ❖ Class 17 = Bridge decks
- ❖ Class 18 = High noise

Traditional Class 8 (Model Keypoints) and overlap will be flagged using the bit flags per TM11-B4.

Upon completion of the LiDAR classification, an accuracy assessment is performed utilizing the previously described NVA and VVA LiDAR checkpoints. As previously stated, the vertical accuracy (absolute NVA) standard for QL2 LiDAR data is ≤10cm RMSE_z (≤19.6cm at the 95% confidence level [Accuracy_z]). This accuracy holds true for calibrated LiDAR swath, classified LAS and Digital Elevation Models (DEM) deliverables. VVA will be tested to meet ≤29.4cm at a 95th percentile.

Hydro-Flattening

The next step in the process is the hydro-flattening breakline collection required for the development of the hydro-flattened DEMs. Merrick will capture hydro-flattening breaklines for waterbodies greater than or equal to two (≥2) acres; double-sided streams and rivers that are greater than or equal to one hundred feet in width, and; any visible islands greater than or equal to one (≥1) acres. Criteria for *Tidal Waters* are not applicable. No single-line streams or drainages will be collected, nor will any planimetric features that could be utilized as traditional breaklines. All hydro-flattening breaklines requires monotonicity.

Pilot Project

Once significant LiDAR collection has been achieved and confirmed, Merrick will coordinate with ISGS a project location of no less than four (4) tiles within each county for processing and preparing deliverables as a Pilot Project.

Deliverable Products

At the conclusion of the data processing steps, Merrick will commence with developing and formatting the final deliverables. Said deliverables are the sole ownership of UIUC / ISGS, and Merrick has no intention of retaining any rights to the final products. Deliverables will meet the

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requirements stated in the RFP and/or TM11-B4. The following outlines the proposed high-level deliverables:

- ❖ Raw LiDAR point cloud
 - Fully compliant ASPRS LAS 1.4, point record format 6
 - Calibrated
 - By swath
 - Intensity values normalized (rescaled) to 16-bit
 - FGDC-compliant metadata
- ❖ Classified LiDAR point cloud
 - Fully compliant ASPRS LAS 1.4, point record format 6
 - By tile
 - Intensity values normalized (rescaled) to 16-bit
 - FGDC-compliant metadata
- ❖ Bare-earth DEM
 - 1m cell size 32-bit floating point raster in ERDAS IMG format
 - Bare-earth (hydro-flattened)
 - Culverts will not be removed from the DEMs
 - Bridges will be removed from the DEMs
 - By tile and by county
 - FGDC-compliant metadata
- ❖ Hydro-flattened breaklines
 - Project-wide Esri feature class(es) for insertion into file geodatabase
 - FGDC-compliant metadata
- ❖ Intensity Images
 - 1m cell size 8-bit, 256 color gray scale in ERDAS IMG format
 - By tile and by county
 - FGDC-compliant metadata
- ❖ Control
 - Survey report
 - Esri shapefile format
 - FGDC-compliant metadata
- ❖ FGDC-compliant metadata (project level)
- ❖ Detailed LiDAR Mapping / Project Report

Compensation:

Based upon the *Project Understanding* and *Professional Services* above and upon the Qualifications section that follows, we propose professional service fees as follows:

1. Basic Services FEES

For the Basic Services defined in the *Professional Services* section above, we propose a **FIXED FEE** of **\$300,000.00** payable according to the following breakdown of total compensation:

Task Name	% of Phase	Lump Sum Fee
Survey Control / LiDAR Checkpoints	7.12%	\$

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LiDAR Acquisition	43.74%	\$
LiDAR Post-processing (Laser, IMU, GNSS) / LiDAR Calibration	9.03%	\$
LiDAR Classification	22.36%	\$
Breakline Collection	12.63%	\$
Deliverable(s) Preparation and QA/QC	5.13%	\$
Total	100.00%	\$

Qualifications:

Merrick is an employee-owned, multidiscipline engineering and geospatial firm that serves a diverse range of private companies and public agencies. Founded in 1955, Merrick initially provided surveying and engineering services to the electric utility industry. Over the years, the company expanded its capabilities to include geospatial services, engineering, architecture, and project management services for clients in many industries. Merrick has been consistently registered in the top 150 of Engineering News Record's "Top 500 Design Firms" and has received numerous quality achievement awards for outstanding service since its inception.

Merrick's GeoSpatial Solutions (GSS) Team has delivered digital mapping, Geographic Information System (GIS) conversion and application services since 1984. Merrick's record of outstanding performance is based on two key factors: (1) fully integrated infrastructure and, (2) uniquely responsive approach to client service. Merrick is an organization of approximately 500 team players that are dedicated to meeting each client's needs in a fully accountable, timely, and cost-effective manner. Merrick provides a progressive, interactive organizational climate and the industry's most advanced technical resources to ensure the highest level of personal performance from every team member.

LiDAR has revolutionized the acquisition of digital elevation data for large-scale mapping applications as organizations, both public and private, endeavor to access the most accurate information for their applications. Merrick has embraced this technology since 1997 and has successfully provided these highly specialized services to clients for a variety of applications including UIUC / ISGS.

Attachments:

The list of attachments below reference documents from the website for University Office of Capital Programs and Real Estate Services (UOCPres). To expedite the processing of the documentation, the University of Illinois requires all vendors to follow the electronic file naming convention listed on the following link:

https://www.uocpres.uillinois.edu/UserFiles/Servers/Server_7758/file/UI/ProjDocs/forms/nameconvention.pdf

Only pdf format is allowed unless otherwise noted. Merrick understands that any documents provided to the University in a format other than pdf or noted format or without using this file naming convention may be rejected.

Attachment List

1. **Professional Services Agreement – Attachment D (sheet 2)**
https://www.uocpres.uillinois.edu/UserFiles/Servers/Server_7758/file/UI/ProjDocs/forms/PSA

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[AttachmentD-MAFBECert.pdf](#)

- PSAAttachmentD-MAFBECert.pdf
2. **Upside Input Worksheet** as an Excel File
- Merrick_upside_input_V1_DataAcquisition&Processing_Boone&Winnebago_120617.xlsx

Respectfully submitted,



Doug Jacoby, CMS, GISP
Geomatics – GSS Practice Lead / Project Manager
Merrick & Company