Minnesota Department of Natural Resources

Management Resources – Contracting
500 Lafayette Road, St. Paul, MN 55155
651-259-5490

February 9, 2012

Woolpert Inc.
Jeff Padgett
4544 Idea Center Blvd.
Dayton, OH, 45430-1500

RE Minnesota Central Lake Region LIDAR Acquistion
Contract 40549, Purchase Order 3-13038

Dear Mr. Padgett,

Enclosed find your executed copy of the Professional and Technical Services Work Order Contract with the Department of Natural Resources, Operations Services, for the project listed above. This agreement is issued under the authority of Contract Number 40549 and is subject to all provisions of the Professional and Technical Services Contract that is incorporated by reference.

The above referenced purchase order number should be put on all correspondence regarding this contract. The invoice shall be sent directly to the State's Authorized Representative, Tim Loesch. He will verify that indeed the services were performed per the terms of the agreement and then forward the invoices to this office for payment.

We look forward to working with your organization.

Sincerely,

Deb Johnson
Contract Coordinator

Cc. Tim Loesch

Enc.

Contract 40549
T-Number 1029G
Purchase Order 3-13038

STATE OF MINNESOTA
PROFESSIONAL AND TECHNICAL SERVICES
WORK ORDER CONTRACT
Minnesota Central Lakes Region LIDAR Acquisition

This work order contract is between the State of Minnesota acting through its Commissioner of Natural Resources, 500 Lafayette Road N., St. Paul, MN 55155-4016 ("State") and Woolpert, Inc., 4454 Idea Center Blvd., Dayton, OH 45430-1500 ("Contractor"). This work order contract is issued under the authority of Master Contract T-Number 1029G, Contract _40549_, and is subject to all provisions of the master contract which is incorporated by reference.

Work Order Contract

1 Term of Contract

1.1 ***Effective date:*** January 13, 2012, or the date the State obtains all required signatures under Minn. Stat. § 16C.05, subd. 2, whichever is later.
The Contractor must not begin work under this contract until this contract is fully executed and the Contractor has been notified by the State's Authorized Representative to begin the work.

1.2 ***Expiration date:*** June 30, 2013, or until all obligations have been satisfactorily fulfilled, whichever occurs first.

2 Contractor's Duties

The Contractor, who is not a state employee, will collect and process for LIDAR Acquisition 11,690 square miles of the Central Lakes Region to include the Minnesota counties of Aitkin, Cass, Hubbard, Itasca, Koochiching, Todd, and Wadena. All work shall be completed per the terms and standards as outlined in *Exhibit A,* which is attached and incorporated herein.

No terms or conditions of Exhibit A shall be construed to modify, diminish or derogate the terms and conditions of this contract.

3 Consideration and Payment

3.1 ***Consideration.*** The State will pay for all services performed by the Contractor under this work order contract as follows:

(1) ***Compensation.*** The Contractor will be paid at a rate of $90.00 per square mile of LIDAR Acquisition and processing.

(2) ***Travel Expenses.*** Reimbursement for travel and subsistence expenses actually and necessarily incurred by the Contractor as a result of this work order contract will not exceed $0.00.

(3) ***Total Obligation.*** The total obligation of the State for all compensation and reimbursements to the Contractor under this work order contract will not exceed $1,052,100.00
{One Million Fifty Two Thousand One Hundred Dollars}.

3.2. ***Invoices.*** The State will promptly pay the Contractor after the Contractor presents an itemized invoice for the services actually performed and the State's Authorized Representative accepts the invoiced services. Invoices must be submitted timely and according to the following schedule:
The Contractor may bill monthly for services completed to the satisfaction of the Project Manager.

4 Project Managers

The State's Project Manager is Tim Loesch, 500 Lafayette Road N., St. Paul, MN 55155, 651-259-5475. The State's Authorized Representative will certify acceptance on each invoice submitted for payment.

The Contractor's Project Manager is Jeff Padgett, 4454 Idea Center Blvd., Dayton, OH 45430, 937-461-5660. If the Contractor's Project Manager changes at any time during this work order contract, the Contractor must immediately notify the State.

5 E-Verify Certification (In accordance with Minn. Stat. §16C.075)

For services valued in excess of $50,000, Contractor certifies that as of the date of services performed on behalf of the State, Contractor and all its subcontractors will have implemented or be in the process of implementing the federal E-Verify program for all newly hired employees in the United States who will perform work on behalf of the State. Contractor is responsible for collecting all subcontractor certifications and may do so utilizing the E-Verify Subcontractor Certification Form available at http://www.mmd.admin.state.mn.us/doc/EverifySubCertForm.doc. All subcontractor certifications must be kept on file with Contractor and made available to the State upon request.

1. STATE ENCUMBRANCE VERIFICATION

Individual certifies that funds have been encumbered as required by Minn. Stat. §§ 16A.15 and 16C.05.

Signed: Deb Johnson

Date: 1/20/12

Contract 40549

2. CONTRACTOR

The Contractor certifies that the appropriate person(s) have executed the contract on behalf of the Contractor as required by applicable articles, bylaws, resolutions, or ordinances.

By: JP M Padgett

Title: Senior Vice President

Date: January 17, 2012

3. STATE AGENCY

By: Steve Hurd
(with delegated authority)

Title: Director

Date: 1/30/12

4. COMMISSIONER OF ADMINISTRATION

As delegated to Materials Management Division

By: Lynette M Padgett

Date: 2/3/12

27864

WOOLPERT

DESIGN GEOSPATIAL INFRASTRUCTURE

Exhibit A

December 09, 2011

Debra Johnson
Department of Natural Resources
500 Lafayette Road, Box 16
St. Paul, Minnesota 55155

RE: State of Minnesota LiDAR Project
CFMSW Contract Number B41672
T-Number 1029G
Work Order #5
Project Name – Minnesota Central Lakes Region LiDAR Acquisition

Dear Ms. Johnson

Woolpert is pleased to submit the following cost proposal for the State of Minnesota LiDAR Project, Work Order #5, Project Name, Minnesota Central Lakes Region LiDAR Acquisition. We are committed to begin work promptly upon full execution of the work order.

Woolpert understands that the Minnesota Department of Natural Resources' goal is to acquire new LiDAR data. Woolpert possesses the knowledge and has the capacity to perform all the work outlined in the Request for Cost Proposal. We also have the knowledge of the changing geodetic, geographic, and climatic conditions across the State of Minnesota.

We are aware of the public services, social and economic challenges facing the region and have provided a proven project approach with a competitive fee. All work will be performed in Minnesota and at Woolpert's headquarters located in Dayton, Ohio.

If you have any questions about the material presented, please contact me as I am looking forward to the opportunity to discuss this project with you further and continuing our mutually beneficial working relationship. Thank you.

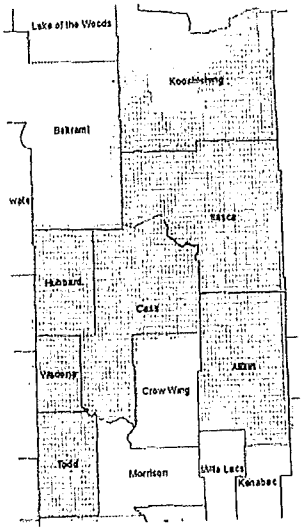
Sincerely,

Woolpert Inc.

Jeff Padgett, CP, PSM
Project Director

Project Understanding

Woolpert understands the project consist of the collection of high-resolution 1.5-meter elevation data using Light Detection and Ranging (LIDAR) systems.



Project Area

The geographic area of this work order includes the Minnesota counties of Aitkin, Cass, Hubbard, Itasca, Koochiching, Todd and Wadena. There are a total of 3,663 1/16 USGS 1:24,000 scale quadrangle tiles covering a land area of approximately 11,690 square miles along with a 100-meter buffer beyond the project boundary.

Project Timeline

The acquisition of data must be done in the spring of 2012 when conditions for collection have been approved by the State of Minnesota. All data must be delivered to the State by June 30th, 2013.

Project Specifications

The project specifications are defined in the Request for Cost Proposal and are based upon the USGS National Geospatial Program LiDAR Guidelines and Base Specification V13 and include additional requirements above and beyond this specification.

Project Approach

Woolpert proposes the following approach.

Project Planning

Once we receive notice to proceed, Woolpert will formalize the scope of services into a project plan. During this phase, we will develop a plan that covers every phase of the project, detailing how we will achieve the desired results. Based closely on the negotiated scope of services, this plan will be a step-by-step guide for completing the project. This formal planning phase helps ensure that the final deliverables meet the technical specifications as outlined in the task order.

Datums

The Spatial Reference System will be: UTM Zone 15, NAD83, Meters; NAVD88, Meters. Data will reference the Geoid model of 2009 (Geoid 09).

Ground Control

Field crews will collect sixty (60) ground control points (GCPs) dispersed throughout the project area. The GCPs will be collected utilizing a Static GPS approach, with one base station (unmanned) and two or three roving receivers. The accuracy of the GCPs will be second order or better horizontally and third order or better vertically as defined by the NGS. These points will be located on open, bare earth surfaces with a level slope to enable effective assessment of swath-to-swath reproducibility and ground truthing 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.

Woolpert will use twenty (20) check points. The check points will be dispersed throughout the project to maintain statistical independence in the assessment of absolute accuracy. These new quality check points will provide a reliable assessment of the LiDAR surface model. These points will be carefully planned and selected within and equally distributed over the priority areas. They will be located in open terrain, where there is a high probability that the sensor will have detected the ground surface, with influence from the surrounding vegetation. The 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.

Woolpert understands the State and its partners may obtain 20 test points per land use class across five standard cover classes (Open, Tall Grass, Brush, Forested, and Urban) and will perform accuracy validation to comply with NDEP Elevation guidelines.

All ground control survey activities will be coordinated, directed and supervised by a Woolpert Professional Surveyor.

Airborne GPS

Simultaneous to the airborne LiDAR data collection missions, Woolpert will collect static (1 Hz recording frequency) survey data on two or more survey control points using dual-frequency DGPS base stations. Time-indexed GPS data are used to correct the continuous onboard measurements of aircraft position recorded throughout the mission. The GPS time will be provided in standard GPS week format.
Our plan is to use existing NGS control for the project area that meets the minimum criteria of currency, reasonable access, and proximity to the mission area. Woolpert will occupy each control point for a minimum of two sessions to verify and update control coordinates. For the existing marks, locations will be verified by processing at least one GPS session of at least two hours duration and comparing computed position with that published by NGS. Our normal procedure is to run multiple occupations of base control points. A minimum of two base stations located within 60 miles will be used for the LiDAR missions. When appropriate, Woolpert will incorporate State of Minnesota COR stations into our ABGPS mission.

LiDAR

Woolpert will obtain LiDAR data across the entire 11,690 square miles (which includes the 100-

meter buffer). Our extensive flying experience has made us well-versed in Federal Aviation Administration rules and procedures for obtaining clearances. Should the project include restricted air space areas, Woolpert will work with MNDNR and the necessary federal agencies to obtain clearance to work within the any restricted areas.

Acquisition: Woolpert owns and operates three Cessna 404 aircraft along with two Leica ALS50 II MPiA and one Optech Gemini ALTM LiDAR systems. These systems are capable of ranging the terrain from 150 kHz to 167 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 post spacing of 1.5 meter. The new LiDAR data will be obtained for the entire project area consisting of point number, X coordinate, Y coordinate and Z coordinate, along with an intensity value.
The scan angle will be 40 degrees. Woolpert has used the 40 degree scan angle for our USGS task orders. We are confident that by performing our calibrations we will meet the required accuracy.

The following are the proposed specifications for the LiDAR acquisition:

- Flying Height.....7,800' AGL
- Scan Angle .....40 degrees (±20 from Nadir)
- Nominal Post Spacing..... 1.5 meters
- Side Lap.....avg. 20%

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

LiDAR data acquisition will occur under leaf-off conditions, while no snow is on the ground, rivers are within their channels at or below normal levels, when the sky is sufficiently clear of clouds, smoke and atmospheric haze. The proposed window of LiDAR data acquisition is the spring of 2012, weather and ground conditions permitting.

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.

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 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 (USGS 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) and highest hit models as triangulated surfaces and export as ESRI 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). The DEM will be produced to prevent clustering effects and ensure uniform densities throughout the data set. The DEM will be spaced so that 90% of the cells in a 3 x 3 meter grid placed over the data will contain at least one LiDAR point.

Breakline Compilation Along Waterbodies: 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 100-feet, will be compiled in the direction of flow, with both sides of the stream maintaining an equal gradient elevation. The hydrologic flattening of the LiDAR data will be performed for inclusion into the National Elevation Dataset (NED). Woolpert proposes the following steps to perform the hydrologic flattening and hydro-enforcement of water bodies.

1. Woolpert will use the LiDAR bare-earth data and LiDAR intensity imagery.
2. LiDAR-grammetry stereo models of intensity imagery superimposed onto a LiDAR stereo model will be produced. The hydro features will be compiled in a 3-D environment, using a digital softcopy photogrammetric work station.
3. All lakes, reservoirs and ponds will be compiled as closed polygons. The closed water body polygons will maintain a constant elevation.
4. All islands with a surface area of approximately 2-acres or greater (appox. 350' diameter for a round island) shall be captured and points within these features are to be classified and represented on all derived products.

5. All rivers, creeks, and streams will be compiled in the direction of flow. Both sides of streams greater that 100-feet in width will be compiled while maintaining an equal gradient elevation.
6. Steams should break at road crossings (culvert locations). These road fills should not be removed from the DEM. However, streams and rivers should not break at bridges. Bridges should be removed from the DEM. When the identification of a feature as a bridge or culvert cannot be made reliably, the feature should be regarded as a culvert. Bridges, 100 foot or longer, should be classified into reserved class value = 14 so that they can be subsequently identified.
7. Rivers, creeks, and streams, at a nominal minimum width of 100-feet or greater and lakes, reservoirs and ponds greater than 2-acres in size will be hydrologically flattened.
8. DEM points along water bodies subject to hydrologic flattening will be reclassified from within a five (5) foot buffer along the hydrologic feature breaklines.
9. All remaining DEM points will be reclassified inside the hydrologic features.
10. The LiDAR mass points and hydrologic feature breaklines will be used to generate a new digital elevation model.
11. The new hydrologically flattened DEM will be delivered in ESRI Floating Point Grid format based upon the tile layout.

Tile Layout: The tile scheme for delivery of products is USGS 16th 1:24,000 quadrangle tiles and will be provided to Woolpert by the State. The tile scheme will be used for all deliverables. Data will fill entire tile with no void areas and without overlap. Tiled deliverables will be edge-matched seamlessly in both the horizontal and vertical.

Accuracy Standards

Positional Accuracy Validation: The absolute and relative accuracy of the data, both horizontal and vertical, relative to known control, will be verified prior to classification and subsequent product development. A detailed report of this validation will be a deliverable.

Classification Accuracy: Within any 1km x 1km area, no more than 2% of points will possess a demonstrably erroneous classification value. This includes points in Classes 0 and 1 that should correctly be included in a different Class required by the contract.

The 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 will read, "Tested __ (meters, feet) vertical accuracy at 95 percent confidence level."

Automated and manual filtering for LiDAR products shall use the following minimum performance for artifact/feature removal from the bare earth model: The bare earth surface model shall have a minimum of 95% of surface canopy artifacts, including buildings, vegetation, bridges or overpass structures removed.

Woolpert would like to discuss with the State the possibility of using 18 cm vertical accuracy instead of 15 cm. vertical accuracy for some areas within the project. We believe 15 cm can be

obtained for the Open, Tall Grass, and Urban land use categories; however some of the remote and dense brush/ forested areas would be better suited using a 18 cm accuracy standard.

FGDC Compliant Metadata

Task order level metadata describing the LiDAR production process shall be submitted as a deliverable. Tile level metadata is not required for this project.

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 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 calibration processes.
- Attributes present in the data set (e.g. X, Y, Z, intensity, all with numbers of significant figures specified).
- Processing steps including methodology used for breakline collection and hydro-flattening.
- Positional accuracy including validation of:
  - The point data (absolute, within swath, and between swaths).
  - The bare earth surface (absolute).
  - Other optional deliverables as appropriate.

A project report will be provided as part of the final delivery lot. At a minimum, the report will include a record of field work procedures, data derivation and adjustments, quality control procedures and results, any problems encountered and solutions used in resolving such problems, and a statistical report summarizing the results of the airborne GPS adjustment and the overall accuracy of the adjusted IMU data.

Schedule

The acquisition of data will be performed in the Spring of 2012 when conditions for collection have been approved by the State of Minnesota. All data will be delivered to the State on or before June 30th, 2013.

Fee

The fee for the above products and services is as follows:

New LiDAR data at an average post spacing of 1.5 meters for 11,690 sq. miles (area per 12/5/11 Questions and Answers to RFP - including the 100-meter buffer) - **$1,052,100.00** ($90.00 per sq. mile)

Deliverables

1) Metadata

- Collection Report detailing mission planning and flight logs.
- Survey Report detailing the collection of control and reference points used for calibration and QA/QC.
- Processing Report detailing calibration, classification, and product generation procedures including methodology used for breakline collection and hydro flattening
- QA/QC Reports (detailing the analysis, accuracy assessment and validation of:
  - The point data (absolute, within swath, and between swath)
  - The bare-earth surface (absolute)
  - Other optional deliverables as appropriate
- Control and Calibration points: All control and reference points used to calibrate, control, process, and validate the LiDAR point data or any derivative products will be delivered.
- Geo-referenced, digital spatial representation of the precise extents of each delivered dataset. This should reflect the extents of the actual LiDAR source or derived product data, exclusive of Triangular Irregular Network (TIN) artifacts or raster NODATA areas. A union of tile boundaries or minimum bounding rectangle is not acceptable. ESRI Polygon shapefile is preferred.
- Product metadata (FGDC compliant, XML format metadata). One file for each:
  - Project
  - Lift
  - Tiled deliverable product group (classified point data, bare-earth DEMs, breaklines, etc.).

2) Classified Point Cloud

- Fully compliant LAS v1.2, Point Record Format 1, 3, 4, or 5
- Georeference information included in LAS header GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each return.
- Intensity values (rescaled to 8-bit)
- Tiled delivery, without overlap (tiling scheme Specified in Data Processing and Handling section #15)
- Classification Scheme:
  - 1 = processed but unclassified
  - 2= Bare Earth Ground
  - 4 = Vegetation (low, medium, high)
  - 6 = Buildings, Bridges and other man-made structures
  - 7 – Noise (Low or High, manually identified, if needed)
  - 8 = Model KeyPoints (Points filtered to those necessary to create 2' contours)
  - 9 = Water
  - 10 = Ignored Ground (breakline-proximity=nominal point spacing)
  - 14 = Bridge decks (100' or greater span)

3) Bare Earth Surface (raster DEM)

- Cell Size of 1 meter
- Delivery in an ESRI, 32-bit floating point raster format
- Georeference information shall be included in raster file
- Tiled delivery, without overlap
- DEM tiles will show no edge artifacts or mismatch
- Void areas (i.e., areas outside the project boundary but within the tiling scheme) shall be coded using a unique "NODATA" value. This value shall be identified in the appropriate location within the file header.
- Depressions (sinks), natural or man-made, are not to be filled (as in hydroconditioning and hydro-enforcement).
- Water Bodies (ponds and lakes), wide streams and rivers ("double-line"), and other water bodies as defined in Section III are to be hydro-flattened within the DEM. Hydro-flattening shall be applied to all water impoundments, natural or man-made, that are larger than ~2 acre in area (equivalent to a round pond ~350' in diameter), to all streams that are nominally wider than 100', and to all non-tidal boundary waters bordering the project area regardless of size.

4) Breaklines

- All breaklines developed for use in hydro-flattening shall be delivered as an ESRI feature class (PolygonZ format).
- Each feature class or shapefile will include properly formatted and accurate georeference information in the standard location.
- Breakline elevations will use the same coordinate reference system (horizontal and vertical) and units as the LiDAR point delivery.
- Breakline delivery must be in tiles and must edge-match seamlessly in both the horizontal and vertical.

5) File Structure and Naming Conventions

- The file structure is negotiable however the data deliverables for each tile in a delivery "block" will be provided using the following file storage and naming conventions.

\Geodatabase – folder storing all of the Geodatabases in delivery block. Each geodatabase is to be named for the tile
\LAS – folder storing all of the individual LAS file tiles for the delivery block. Each LAS file is to be named for the tile it represents.
\Metadata – FGDC Compliant metadata. One as project overview and one for each data product.
\Reports – Additional Reports as required or generated by Contractor.

Geodatabase Structure

- Geodatabase name must be based on the tile. For example, **2758-32-01.gdb**
- Geodatabase must contain a feature dataset named **"Terrain_data"**
  - Must contain appropriate Horizontal and Vertical Coordinate Systems Defined
- Breakline feature class is to be named **"Hydro_breaklines"** and stored in **Terrain_data** feature Dataset.

    - 3d polygon feature class
- Bare earth mass points feature class is to be named **"Bare_Earth_Points"** and stored **Terrain_Data**.
    - 3d multi-point feature class
- One Meter DEM is to be named **DEM01** and stored as a raster in the File Geodatabase.

6) Physical Delivery

- All products will be delivered on new USB2 external hard-drives that are to become property of the State.
- All data will be delivered to the State LiDAR Project Manager

Metadata: Task order level metadata describing the LiDAR production process will be submitted as a deliverable. Tile level metadata is not required for this project.

Federal Geographic Data Committee (FGDC) compliant metadata will 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 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 calibration processes.
- Attributes present in the data set (e.g. X, Y, Z, intensity, all with numbers of significant figures specified).
- Processing steps including methodology used for breakline collection and hydro-flattening.
- Positional accuracy including validation of:
    - The point data (absolute, within swath, and between swaths).
    - The bare earth surface (absolute).
    - Other optional deliverables as appropriate.

A project report will be provided as part of the final delivery. At a minimum, the report will include a record of field work procedures, data derivation and adjustments, quality control procedures and results, any problems encountered and solutions used in resolving such problems, and a statistical report summarizing the results of the airborne GPS adjustment and the overall accuracy of the adjusted IMU data.

Additional Services

Woolpert understands that clients desire more from their base mapping products such that additional value is derived from regional data collection. Woolpert is constantly investing and developing new methods for creating these value-added products for our clients. Our Remote Sensing Group was created specifically to focus on the development of these value-added

products using LiDAR data. Woolpert would be most interested in teaming with any communities or state agencies in providing "buy-up" remote sensing services within this project area. Woolpert would be pleased to collaborate with MnDNR in promoting any partnerships in conjunction with this task order.

The Woolpert team has extensive experience in performing the common buy-up features listed in the USGS guidelines. Below are just a few examples for value-added services:

- Woodland Landcover Polygons with elevations (includes entire project area) Fee.....$11.98 per sq. mi.
- Intensity Images ..... n/c per sq. mi.
- Increased resolution LiDAR at nominal post spacing of 1-meter ...$96.00 per sq. mi.*
- Hydro Flattening of streams 50 feet or greater.....$20.00 per sq. mi.*
- Rural area building polygons 20' x 20' or greater.....$20.00 per sq. mi.*
- Increased resolution area building polygons 10' x 10' or greater...$95.00 per sq. mi.*

**Note : The above costs are based upon a 500 sq. mile contiguous area. Woolpert can provide a cost based upon a smaller area if desired by the State.*