Conduct Comprehensive LiDAR Mapping
and Aerial Orthophotography
for the Buttermilk Creek Watershed
and the Western New York Nuclear Service Center
RFP No. 1861

Proposals Due: (March 8, 2010) by 5:00 PM Eastern Time*

NYSERDA is seeking proposals for the acquisition of Light Detection and Ranging (LiDAR) data and aerial orthophotography of the Western New York Nuclear Service Center (WNYNSC) and the balance of the Buttermilk Creek Watershed, and the development of several LiDAR data derivative products. The LiDAR data and orthophotography will need to be of high resolution and quality to yield the functional Digital Elevation Models (DEMs) and imagery that are the goals of this project. Significant post-processing of the LiDAR data and aerial photography will be required to develop the specified deliverable products.

Proposal Submission: Proposers must submit (eight) (8) copies of the proposal with a completed and signed Proposal Checklist attached to the front of each copy, one of which must contain an original signature. Proposals must be clearly labeled and submitted to:

Roseanne Viscusi, RFP 1861
NYS Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

If you have technical questions concerning this solicitation, contact Lee Gordon at (716) 942-9960, ext. 4963 or LMG@nyserda.org. If you have contractual questions concerning this solicitation, contact Venice Forbes at (518) 862-1090, ext. 3507 or VWF @nyserda.org.

No communication intended to influence this procurement is permitted except by contacting Lee Gordon at 716 942-9960, ext. 4963 or LMG@nyserda.org. Contacting anyone other than this Designated Contact (either directly by the proposer or indirectly through a lobbyist or other person acting on the proposer's behalf) in an attempt to influence the procurement: (1) may result in a proposer being deemed a non-responsible offerer, and (2) may result in the proposer not being awarded a contract.

*Late proposals and proposals lacking the appropriate completed and signed Proposal Checklist may be returned. Faxed or e-mailed proposals will not be accepted. Proposals will not be accepted at any other NYSERDA location other than the address above. If changes are made to this solicitation, notification will be posted on NYSERDA's web site at www.nyserda.org.

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Request for Proposals
No. 1861
Conduct Comprehensive LiDAR Mapping and Aerial Orthophotography for the Buttermilk Creek Watershed and the Western New York Nuclear Service Center

NYSERDA

New York State
Energy Research and
Development Authority

Lee M. Gordon, Associate Project Manager
The New York State Energy and Research Authority
West Valley Site Management Program
10282 Rock Springs Road
West Valley, NY 14171
Ph. 716-942-9960 x4963
Fax. 716-942-9961
Email. LMG@nyserda.org

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TABLE OF CONTENTS

1.0. Proposal Requirements ..... 5 -

1.1. Proposal Content ..... 5 -

1.1.1. Part 1 – Technical and Management ..... 5 -

1.1.2. Part II – Cost and disclosures ..... 5 -

2.0. Introduction ..... 5 -

2.1. Definitions ..... 6 -

2.2. The Western New York Nuclear Service Center (WNYNSC) ..... 8 -

2.3. Geology and Geomorphology ..... 8 -

2.4. Land Use and Land Cover ..... 9 -

2.5 Erosion Research ..... 9 -

2.6. Other Anticipated Activities ..... 9 -

3.0. Program Requirements ..... 10 -

3.1. Scope ..... 10 -

3.2. General Performance Standards ..... 10 -

3.3. Project Areas ..... 11 -

3.3.1. Project Area 1 ..... 11 -

3.3.2. Project Area 2 ..... 11 -

3.4. Information provided by NYSERDA ..... 11 -

3.5. Organization/Personnel ..... 11 -

3.6. Schedule ..... 12 -

3.7. Project Kick-Off ..... 12 -

3.8. Aircraft ..... 12 -

3.9. Flight Regulations ..... 12 -

3.10. Re-flights ..... 12 -

3.11. Geodetic and GPS Control ..... 13 -

3.12. LiDAR Services ..... 14 -

3.12.1. Allowable LiDAR Acquisition Conditions ..... 14 -

3.12.2. Sensor and Equipment ..... 14 -

3.12.3. System Calibration ..... 15 -
3.12.4. Flight Planning ..... 15 -
3.13. LiDAR Performance Standards ..... 16 -
3.13.1. Horizontal Accuracy Requirement ..... 16 -
3.13.2. Vertical Accuracy Requirement ..... 17 -
3.13.3. Point spacing, post spacing, and contour generation ..... 17 -
3.13.4. Data Voids ..... 17 -
3.13.5. The SDA and NDA Geomembrane Covers ..... 18 -
3.13.6. Artifacts ..... 19 -
3.13.7. Quality Control (QC) ..... 19 -
3.13.8. Quality Assurance (QA) ..... 19 -
3.13.9. Error Analysis, Assessment, and Correction ..... 21 -
3.14. LiDAR Deliverables ..... 22 -
3.14.1. Pre-flight submittals ..... 22 -
3.14.2. Post-Project LiDAR Deliverables ..... 23 -
3.15 Aerial Photography and Orthoimagery Services ..... 30 -
3.15.1. Allowable Aerial Imagery Acquisition Conditions ..... 30 -
3.15.2. Sensor and Equipment ..... 31 -
3.15.3. Camera Calibration ..... 31 -
3.15.4. Flight Planning ..... 31 -
3.16. Aerial Photography and Orthoimagery Performance Standards ..... 33 -
3.16.1. Scale and Resolution: Project Area 1 ..... 33 -
3.16.2. Scale and Resolution: Project Area 2 ..... 33 -
3.16.3 Ground Control ..... 33 -
3.16.4. Analytical Aerotriangulation ..... 34 -
3.16.5. Digital Orthorectified Image Characteristics ..... 34 -
3.16.6. Quality Control and Quality Assurance ..... 34 -
3.17. Aerial Photography and Orthoimagery Deliverables ..... 36 -
3.17.1. Pre-flight submittals ..... 36 -
3.17.2. Post-Project Aerial Photography and Orthoimagery Deliverables ..... 37 -

3.18. Project Completion ..... 39 -
3.18.1. Project Completion Report ..... 39 -
3.18.2. Delivery of Digital Data ..... 40 -
3.18.3. Acceptance ..... 40 -
3.18.4. Rights ..... 41 -
4.0. Proposal Evaluation and Selection Criteria ..... 41 -
4.1. Compliance with RFP instructions ..... 41 -
4.2. Quality of Proposal ..... 41 -
4.3. Technical Expertise ..... 41 -
4.4. LiDAR and Camera Systems ..... 41 -
4.5. Quality Control ..... 41 -
4.6. Staff Qualifications ..... 42 -
4.7. Similar Project Experience ..... 42 -
4.8. Subcontracting ..... 42 -
4.9. Organization ..... 42 -
4.10. Delivery Schedule ..... 42 -
4.11. Costs ..... 42 -
4.12. Example datasets ..... 42 -
5.0. General Conditions ..... 43 -
5.1 Proprietary Information ..... 43 -
5.2 Omnibus Procurement Act of 1992 ..... 43 -
5.3. State Finance Law sections 139-j and 139-k ..... 44 -
5.4. Tax Law Section 5-a ..... 44 -
5.5. Contract Award ..... 45 -
5.6. Limitation ..... 45 -
5.7. Disclosure Requirement ..... 45 -
6.0. List of Attachments ..... 45 -
6.1. Attachment A – RFP Checklist ..... 46 -
6.2. Attachment B – Disclosure of Prior Findings of Non-Responsibility Form ..... 46 -
6.3. Attachment C – Contract Pricing Proposal Instructions Form ..... 46 -

6.4. Attachment D – Project Areas 1 & 2, Including Buffer Areas ..... 46 -

6.5. Attachment E -- The West Valley Demonstration Project (WVDP) industrial complex, the State Licensed Disposal Area (SDA), and the Nuclear Regulatory Commission Licensed Disposal Area (NDA) property boundaries ..... 46 -

6.6. Attachment F – The 2001 National Land Cover Dataset for Project Areas 1 & 2..... 46 -

6.7. Attachment G – Geodetic Control Points ..... 46 -

6.8. Attachment H – Example Ground Control/Test Point Datasheet ..... 46 -

6.9. Attachment I – Sample Agreement ..... 46 -

1.0. Proposal Requirements

1.1. Proposal Content

A complete response to this request for proposals shall include two parts:

1.1.1. Part 1 – Technical and Management

1. Background/Objectives (3 pages maximum);
2. Services to be Provided, including Equipment Specifications and Data Production/Processing methods (10 pages maximum);
3. Management Plan that describes the approach for providing the required services, including a Project Organizational Chart and Schedule for the Work (5 pages maximum);
4. Current Qualifications Statement that clearly presents the respondent's education, training, and experience relevant to the scope of work;
5. Three (3) to five (5) examples of completed contracts within the last five (5) years similar to the proposed scope and level of effort, including contract name, and client reference contact information
6. Letters of commitment from all subcontractors and teaming partners (if applicable);
7. Completed "Proposal Checklist form (Exhibit A) to be attached to the front of all copies of the proposal.
8. All map hardcopies
9. All soft-copy map data and example datasets on CD or DVD

1.1.2. Part II – Cost and disclosures

1. Cost Proposal including hourly rates and any other applicable costs or rates included on the attached "Contracts Pricing Proposal" form (Exhibit C, instructions included);
2. "Disclosure of Prior Findings of Non-Responsibility form (Exhibit B);
3. Disclosure of Indictment/Conviction of a Felony (if applicable)
4. NYSERDA Contracts Awarded (if applicable)
5. Prior and/or Competing Proposals (if applicable)

2.0. Introduction

The New York State Energy Research and Development Authority (NYSERDA) owns and manages the Western New York Nuclear Service Center (WNYNSC), the site of a shut-down commercial nuclear fuels reprocessing operation and radioactive waste

landfill. The role of NYSERDA's West Valley Site Management Program is to use objective analysis and solicit multiple perspectives to identify and implement effective approaches to protect the environment and the well-being of the public. NYSERDA is actively involved in a wide range of environmental monitoring and maintenance activities. NYSERDA is committed to conducting appropriate scientific research in order to advance institutional knowledge and capacity for decision making.

In recent years, elevation data and aerial imagery have become increasingly important to modern Geographic Information Systems (GIS). With elevation data and aerial imagery of sufficient accuracy and resolution, GIS software is able to perform complex analyses and modeling to support many different disciplines such as water and land management, erosion assessment and prediction, engineering and architectural design, emergency preparedness and response, etc. Many modern software programs have expanded into three dimensions, using elevation data as the base for aerial imagery and many other data layers. An accurate 3D representation of the land surface allows a number of analyses of complex environmental processes, and in many cases, communication about spatial data in 3D can be much more compelling than traditional 2D maps.

Existing elevation data for the proposed project area is limited to 10-meter U.S. Geological Survey digital elevation models (DEMs) and 7.5' (1:24,000) topographic maps (www.seamless.usgs.gov). These data layers are, in many cases, several decades old and do not have the accuracy or resolution required to produce accurate derivative layers for sophisticated modeling applications. LiDAR elevation data will provide a much greater degree of elevation accuracy and resolution with which to support applications such as contour line generation, hydrologic analysis, erosion modeling, and change detection.

The most current and highest resolution ortophotography for the project area is the 2007 imagery collected by New York State at a 24-inch resolution (www.seamless.usgs.gov). This data is quickly becoming outdated and is not of sufficient quality to allow for visual identification and interpretation of small-scale features. Further, concurrent orthoimagery is necessary for the photogrammetric editing of LiDAR data for the production of LiDAR derivative products.

2.1. Definitions

Words, terms, and/or acronyms used in this Request for Proposals are defined as follows:

CSDGM	Content Standards for Digital Geospatial Metadata
DEM	Digital Elevation Model
DSM	Digital Surface Model, containing all manmade and vegetative features

DTM	Digital Terrain "Bare-Earth" Model
DOE	Department of Energy
GIS	Geographic Information Systems
GPS	Global Positioning System
Hydro- DEM	Hydrologically Corrected DEM
HARN	High Accuracy Reference Network
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FGCS	Federal Geodetic Control Subcommittee
LiDAR	For the purposes of this RFP, LiDAR is defined as an airborne laser system, flown aboard rotary or fixed-wing aircraft, that is used to acquire x, y, and z coordinates of terrain and terrain features that are both manmade and naturally occurring. LiDAR systems consist of an airborne Global Positioning System (GPS) with attendant GPS base station(s), Inertial Measurement Unit (IMU) and light-emitting scanning laser.
NGS	National Geodetic Survey
NAD83(07)	North American Datum of 1983, 2007 adjustment
NAVD88	North American Vertical Datum of 1988
NSSDA	National Standard for Spatial Data Accuracy
NYSERDA	New York State Energy and Research Development Authority
PDOP	Position Dilution of Precision
Respondent	The firm proposing to be the prime contractor for this work
RFP	Request for Proposals

Selected Contractor	The firm contracted to perform the work.
USGS	United States Geological Survey
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project

2.2. The Western New York Nuclear Service Center (WNYNSC)

The New York State Energy and Research Development Authority (NYSERDA) manages the Western New York Nuclear Service Center (WNYNSC, Attachment D), a 3,486 acre site in Northern Cattaraugus County, NY (with a small portion extending into southern Erie County, NY). The WNYNSC is the site of a former commercial nuclear fuel reprocessing operation conducted by Nuclear Fuel Services, Inc. from 1966 to 1972. In 1980, the United States Congress passed the West Valley Demonstration Project (WVDP) Act. The act directed the United States Department of Energy (DOE) to carry out a high level radioactive waste demonstration at the reprocessing complex. As such, DOE currently manages an approximately 179 acre "industrial" portion of the WNYNSC to conduct the WVDP (Attachment E). NYSERDA manages the balance of the 3,486 acre WNYNSC property, including active monitoring and maintenance of a 15 acre shut-down commercial radioactive waste disposal facility known as the State-Licensed Disposal Area (SDA, Attachment E).

2.3. Geology and Geomorphology

The WNYNSC is situated in a glacial landscape that is geologically young – the landscape is still adjusting to the retreat of the Laurentide Ice Sheet some 10,000 to 14,000 years ago. The bedrock of the region consists of Devonian era shale and siltstone, thickly mantled in most areas with sequential glacial tills and lacustrine sediments. The majority of the WNYNSC is contained within the watershed of Buttermilk Creek (with the exception of the northernmost tip of center property, see Figure 1.) Buttermilk Creek flows in a general South-North direction. The creek's headwaters are located two to three miles South and East of the WNYNSC. As Buttermilk Creek crosses the WNYNSC, it becomes deeply incised and is confined within a steep walled gorge in some sections. The Buttermilk Creek watershed consists of upland plateaus (where the WVDP premises and SDA are located) and hilltops that are being incised and eroded by streams downcutting through the erodible glacial tills and glacio-lacustrine sediments. This stream downcutting by knickpoint erosion, the widening of stream valley rims, and the erosion of slopes by gullies are of concern to NYSERDA with regards to the short and long term integrity of critical site facilities.

2.4. Land Use and Land Cover

Attachment F depicts the 2001 National Land Cover Dataset for the Buttermilk Creek Watershed. The watershed is primarily undeveloped forested land. Deciduous forest, evergreen forest, and mixed forest occupy 45%, 11%, and 8% of the land in the watershed, respectively. Approximately 16% of the watershed is used for cultivated crops, while 15% is grassland and/or pasture/hay. There are only two small areas (4%) of concentrated development in the watershed: (1) the WVDP industrial complex and (2) the Hamlet of West Valley located about 3 miles southeast of the WVDP. Other developed areas are generally low intensity and primarily represent roadways and other infrastructure corridors. Less than 1% of the watershed is either open water or wetlands. While the map in Attachment E appears to be fairly accurate, particularly for delineating areas of evergreen cover, the overgrown meadows on the WNYNSC property (many of which were formerly cultivated) have been incorrectly classified as cropland in this 2001 Land Use/Cover Dataset. The reported accuracy for this dataset is 77%.

2.5 Erosion Research

NYSERDA has begun a comprehensive erosion research program that will include, over several years, the assessment, monitoring, mitigation, and prediction of erosion at a number of time and space scales. NYSERDA believes that high resolution topographic data and high resolution orthoimagery will be instrumental for (1) detailed modeling of surface hydrology, even in very small streams (with watersheds as small as 10 acres), (2) the development of detailed topographic maps of individual gullies and stream channels, including the extraction of stream longitudinal profiles and cross-sections (3) providing support for engineering and implementation of erosion controls, (4) detecting movement of critical slopes and rates of erosion in streams and gullies (by repeating the surveys every 5-10 years), and (5) fulfilling NYSERDA's permit requirement (per NYSERDA's Part 380 permit with the New York State Department of Environmental Conservation) to develop detailed maps of the land surface of the SDA and adjacent slopes and stream channels.

2.6. Other Anticipated Activities

NYSERDA plans to also use the high resolution topographic data and orthoimagery to document changes as the WVDP is decommissioned. Over the next several years, a number of decommissioning actions will occur at the WVDP, including the removal of a number of structures and significant earthwork activities. This first topographic survey and imagery dataset will provide a useful "base-case" for the analysis of future decommissioning activities.

NYSERDA also anticipates these datasets would be useful in an emergency management context, whether in the analysis of pre-emergency conditions, site resources, contaminant

fate, etc. Further, these data will provide an existing topographic survey for all areas of the Buttermilk Creek watershed, which in an emergency situation should preclude the need for extensive in-field surveying as part of a mitigation action.

3.0. Program Requirements

3.1. Scope

NYSERDA is seeking proposals for the acquisition of Light Detection and Ranging (LiDAR) data and aerial orthophotography of the WNYNSC and the balance of the Buttermilk Creek Watershed, and the development of several LiDAR data derivative products. The LiDAR data and orthophotography will need to be of high resolution and quality to yield the functional Digital Elevation Models (DEMs) and imagery that are the goals of this project. Significant post-processing of the LiDAR data and aerial photography will be required to develop the specified deliverable products.

NYSERDA has convened a Technical Evaluation Panel (TEP) with representation by NYSERDA, the U.S. Department of Energy, the University at Buffalo, and Buffalo State College, to assist in the selection of this contractor. This Scope of Work is being circulated to solicit bids from firms with geospatial and remote sensing expertise interested in performing this work. Work for this task is expected to begin April 1, 2010 (spring leaf-off conditions). However, the project may be delayed until November 1, 2010 (fall leaf-off conditions). The **respondent** should be amenable to either data collection period.

The success of this task will be, in part, dependent on securing the services of a highly-qualified, professional geospatial/remote sensing company with experience collecting and processing high resolution LiDAR data and orthoimagery.

3.2. General Performance Standards

The underlying performance standards for this project are the Federal Emergency Management Agency's (FEMA's) "Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying" hereafter referred to as "FEMA's Appendix A." The most current version of this document can be obtained from: http://www.fema.gov/library/viewRecord.do?id=2206. Portions of this RFP may exceed FEMA's specifications and therefore the more stringent requirements must be met. If a performance standard is not covered in this RFP, FEMA's standards govern and must be met.

The "Content Standard for Digital Geospatial Metadata" (CSDGM), Version 2 (http://www.fgdc.gov/metadata/csdgm/) is the US Federal Metadata Standard. All deliverable geospatial data products shall contain the requisite metadata in the form and function governed by this standard.

Naming conventions shall kept as simple as possible and should be capable of relating, for example, a DEM or imagery tile to its requisite metadata. Data shall be delivered in straightforward hierarchical digital folder system compatible with Windows XP.

The respondent must clearly and thoroughly identify any and all items in their proposal that deviate from the standards and specifications in this RFP, and the reason for the deviation.

3.3. Project Areas

The project is separated into two project areas (see Attachment D):

3.3.1. Project Area 1

The Western New York Nuclear Service Center (approximately 3486 acres) to include a 1000 foot buffer (indicated by red colored area in Attachment D) outside of the WNYNSC boundary to ensure deliverable products cover the desired area, hereafter referred to as Project Area 1

3.3.2. Project Area 2

The balance of Buttermilk Creek's watershed (approximately 16,453 acres) to include a 2000 foot buffer (6027 acres, indicated by the blue colored area in Attachment D) outside of the watershed boundary to ensure deliverable products cover the desired area, hereafter referred to as Project Area 2.

3.4. Information provided by NYSERDA

NYSERDA (Lee Gordon, Project Manager, LMG@nyserda.org) will provide, at the **respondent's** request, ESRI Shapefiles of the boundaries of Areas 1 and 2, including the buffer areas described above for mission planning purposes. Attachment D identifies Areas 1 and 2, depicting the buffer zones around the WNYNSC and Buttermilk Creek watershed, respectively. Geodetic control point NY HARN D387, located in the southern buffer area for Project Area 2, is also shown in Attachment D.

3.5. Organization/Personnel

The **respondent** shall describe the organizational experience and key personnel qualifications for this project, including, but not limited to project managers, ground survey personnel, flight crews and equipment technicians, and data processing personnel. To be included in a proposal are the educational background and training of the primary project manager, including the breadth and quality of relevant prior and current experience and past performance. The experience of the flight crew, specifically that experience with aerial mapping projects should be included. The **respondent** is

encouraged to submit at least three (3) client references for similar LiDAR projects and at least three (3) client references for similar orthoimagery projects.

3.6. Schedule

The **respondent** shall indicate a proposed schedule for data collection and data processing and shall include a proposed delivery time for all data products and reports relative to the time the "Notice to Proceed" is given. All data and reports shall be delivered to NYSERDA no later than 16 weeks after data acquisition flights are terminated.

3.7. Project Kick-Off

A formal meeting is not required, but if concerns arise during the mission preparation and planning process, NYSERDA or the **selected contractor** may call for a formal pre-flight meeting to resolve issues before the start of LiDAR mapping or aerial photography. NYSERDA and the selected contractor shall negotiate the time and place of the meeting.

The **selected contractor** shall notify the NYSERDA project manager 48 hours prior to the beginning of LiDAR mapping and/or aerial photography mission commencement. This notification shall be written and shall be delivered via mail, email, or facsimile. A "Notice To Proceed" shall be obtained from NYSERDA before LiDAR mapping and/or aerial photography. The "Notice to Proceed" will be a written statement from the NYSERDA project manager that will be delivered via email or facsimile.

3.8. Aircraft

The **respondent** must describe the aircraft proposed for the flight mission(s).

3.9. Flight Regulations

The **selected contractor** shall comply with all required Federal Aviation Administration regulations.

3.10. Re-flights

Any products that do not meet the specifications identified in this RFP must be corrected in a timely manner (at the latest, during the next "leaf-off" period) at no cost to NYSERDA. All re-flights and data processing/delivery must meet with the specifications described herein. The same sensor must be used under the same environmental conditions as discussed in Section 3.12.1 and must meet with accepted flight plans.

3.11. Geodetic and GPS Control

Each dataset and deliverable will be registered to the same local geodetic control. The primary horizontal and vertical reference will be the National Geodetic Survey/New York High Accuracy Reference Network point designated D387 (PID = NC0236, see Attachments D & G). Additional geodetic vertical control points are National Geodetic Survey points L387 (PID=NC0248), K387 (PID=NC0247), A389 (PID=NC0244), F387 (PID=NC0240), and E387 (PID=NC0239). Datasheets for control points listed here and shown in Attachment G are available from the National Geodetic Survey (http://www.ngs.noaa.gov/). All points that are used for geodetic control and are visible from the air (including point D387) will be marked using an appropriate standard aerial photogrammetry target (e.g. Attachment H) prior to data acquisition so that these points are visible in the orthophotography. The **selected contractor** is responsible for locating and identifying control points in the field. The **selected contractor** will acquire all permissions for survey activities requiring entry onto private property.

Differentially corrected GPS base stations to be used for airborne control of mapping aircraft for LiDAR survey and orthophotography shall incorporate NY HARN point D387. This eliminates the possibility that discrepancies may be caused by inconsistencies between different control points and should ensure that all datasets correctly register to other base maps such as New York State Digital Orthophoto Quads (DOQs). The control points used for geodetic control must not be used for quality checking per Section 3.13.8.

Part 1, "Reporting Methodology (FGDC-STD-007.1)," and Part 2, "Standards for Geodetic Networks (FGDC-STD-007.2)," of the Geospatial Positioning Accuracy Standards, published by the Federal Geographic Data Committee (FGDC) in 1998, provide a common methodology for determining and reporting accuracy of horizontal and vertical coordinates for geodetic control points. Additional guidance is included in NOAA Technical Memorandum NOS NGS-58, "Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm)," dated November 1997. The GPS control guidance in FGDC-STD-007.1, FGDC-STD-007.2 and in FEMA's Appendix A shall be followed. As GPS errors constitute the major contribution to aerial remote sensing positional errors, the contractor will be expected to perform data collection under optimum GPS conditions.

The primary projected coordinate system for data reporting shall be the New York State Plane System, West Zone, NAD83(07). Elevations shall be referenced to the NAVD88 datum. This projection and datum shall be used for all surveys and deliverable products unless otherwise noted.

The **respondent** must provide detailed plans for geodetic and GPS control that conform to the above standards and specifications. The procedure and rationale should be as clear as possible, bearing in mind that the spatial control during data collection and processing should be easily replicated, should NYSERDA choose to repeat the project at a later date.

The **selected contractor** shall use the latest NGS geoid model and shall report this model in all metadata. It is important to document what geoid model was used in order to refine the orthometric heights as newer geoid models are published by NGS.

3.12. LiDAR Services

LiDAR data acquisition and processing services must be provided in a format consistent with the following minimum specifications. The **respondent** must clearly and thoroughly identify any and all items in their proposal that deviate from the specifications in this RFP, and the reason for the deviation.

3.12.1. Allowable LiDAR Acquisition Conditions

LiDAR data will be acquired under the following circumstances:

3.12.1.1. Favorable weather conditions free of rain, snow, fog, mist, high wind gusts, and low clouds, as such conditions have been known to degrade the quality of laser return data.

3.12.1.2. Sufficiently clear ground conditions free of flood water, snow, and ice.

3.12.1.3. Normal water levels – sufficiently removed in time from events such as storms that may cause temporarily increased water levels in streams and other water bodies and standing or ponding water on other flat surfaces.

3.12.1.4. During “leaf-off” conditions – when the canopy of the deciduous forest is bare and there is no vegetative growth of agricultural crops.

3.12.1.5. When turbulence is less than moderate and cross winds are less than 20 knots.

3.12.1.5. When the dew point is more than 4 degrees less than relative temperature.

3.12.2. Sensor and Equipment

Respondents must describe the sensor(s) to be used and related specifications to be used for LiDAR data acquisition. On-board and ground-based GPS and Inertial Measurement Unit (IMU) equipment must be described. The pulse rate and average point spacing collected by the sensor and the final point spacing after filtering must be included in the description of the equipment and processing. The **respondent** should indicate their capability for capturing multiple laser returns from a single pulse.

NYSERDA prefers that the **respondent** own all the equipment and own or license all software to be used for the project. This increases the likelihood that the equipment will be properly calibrated and well-maintained.

3.12.3. System Calibration

LiDAR system components are most effectively tested and calibrated by the manufacturer, therefore the **selected contractor** shall provide NYSERDA with evidence of manufacturer calibration for primary system components.

The **respondent** shall submit a comprehensive plan for project-specific total LiDAR system calibration, including when, how, and how often calibration will be conducted. The **selected contractor** shall conduct calibration activities only after the aircraft and crew have been mobilized to the base airport from which the project will be conducted. The **selected contractor** will furnish a comprehensive calibration report, including the identification and description of any systematic errors. While many LIDAR vendors normally advertise their systems deliver an $RMSE_r$ of 1 meter or less, this accuracy is difficult to verify in the absence of project-specific calibration. Proper system calibration requires repetitive overflights of terrain features (calibration test range) of known and documented size and elevation.

3.12.4. Flight Planning

Planning a flight path that considers all aspects of data collection is critical to the success of the mission. An analysis of the project area, project requirements, topography, and other factors will determine the flight path configuration. The project shall include parallel flight lines, and for quality control, shadow elimination, and data supplementation purposes, a number of cross-flight lines. The spacing between the flight lines will depend on the desired amount of sidelap between swaths and the terrain. The density and accuracy of data generated by different equipment vary widely. The **respondent** and **selected contractor** shall have the flexibility of providing a flight path to create the necessary point density to meet posting and accuracy requirements and minimize the occurrence of data voids. Factors that shall be considered when planning the flight include, but are not limited to:

3.12.4.1. Position Dilution of Precision (PDOP)

3.12.4.2. Geomagnetic activity

3.12.4.3. Number of satellites providing coverage

3.12.4.4. Baseline length

3.12.4.5. Flight altitude

3.12.4.6. Airspeed

3.12.4.7. Laser repetition rate

3.12.4.8. Scan frequency

3.12.4.9. Scan angle

3.12.4.10. Side overlap

3.12.4.11. Swath width

3.12.4.12. Line spacing

3.12.4.13. Bank angle between flights

3.12.4.14. Average point spacing and/or points per square meter

The **respondent** shall state the expected values of these factors for both Project Area 1 and Project Area 2 for items 3.12.4.1 to 3.12.4.14 above. The **respondent** shall prepare a proposed flight plan for LiDAR acquisition, which will show on a 1:24,000 map, the flight lines to be utilized. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

The **respondent** shall also provide a brief discussion of any aspects of the flight plan that may be adjusted to best capture topographic data in areas of steep terrain and/or thick evergreen canopy cover.

3.13. LiDAR Performance Standards

The **selected contractor** shall furnish all necessary materials and equipment and shall also supply the supervisory, professional, and technical services personnel required to manage, survey, document, and process all the data associated with LiDAR system mapping, scanning, and digital processing. The **respondent** shall propose to furnish all deliverables as outlined in this RFP.

3.13.1. Horizontal Accuracy Requirement

Minimum horizontal point accuracy shall be 0.5 meter RMSE or better when checked against test points as detailed in Section 3.13.8 for each land cover classification in Sections 3.13.8.1 to 3.13.8.6. The **respondent** shall indicate the expected horizontal

accuracy of elevation products as determined from system studies, calibrations, or other previous experience. The **respondent** shall indicate the relationship between the expected horizontal error and the LiDAR point spacing proposed according to section 3.13.3. The **selected contractor** shall report RMSE values for both pre-flight calibration and post flight data check against test points (see Section 3.13.8).

3.13.2. Vertical Accuracy Requirement

Minimum vertical point accuracy shall be 0.15 meter RMSE or better when checked against test points as detailed in Section 3.13.8 for each land cover classification in Sections 3.13.8.1 to 3.13.8.6. The **respondent** shall indicate the expected vertical accuracy of elevation products as determined from system studies, calibrations, or other previous experience. The **respondent** shall indicate the relationship between the expected horizontal error and the LiDAR point spacing proposed according to section 3.13.3. The **selected contractor** shall report RMSE values for both pre-flight calibration and post flight data check against test points (see Section 3.13.8).

3.13.3. Point spacing, post spacing, and contour generation

The respondent shall propose the target average point spacing they believe necessary to meet the requirements of this RFP based on the vendor-specific equipment, aircraft, flight plan, post processing, etc. The average point spacing shall be geared to the following requirements:

3.13.3.1. Point/Post Spacing

- Area 1: LiDAR acquisition point spacing should support generation of all digital elevation models (DEMs) gridded at 0.5 m post spacing
- Area 2: LiDAR acquisition point spacing should support generation of all digital elevation models (DEMs) gridded at 1.0 m post spacing

3.13.3.2. Contour Generation

- Area 1: LiDAR acquisition should support generation of 1-foot contours to ASPRS Class 1 Standards
- Area 2: LiDAR acquisition should support generation of 2-foot contours to ASPRS Class 1 Standards

3.13.4. Data Voids

A data void is defined as an area not within two times the DEM posting of data points. Data voids may be caused by:

3.13.4.1. Equipment malfunction

3.13.4.2. Deviation from the flight plan

3.13.4.3. The absorption of LiDAR pulses by water or dark objects

3.13.4.4. The intentional removal of data points during bare-earth editing

Data voids caused by equipment malfunction and/or deviation from the flight plan are unacceptable and will require new flights at no cost to NYSERDA. Data voids resulting from removal of LiDAR points on manmade structures are acceptable. Data voids caused by the removal of LiDAR datapoints in areas of dense vegetation are subjected to the following additional guidelines:

3.13.4.5. Area 1
Data voids due to removal of vegetation that are greater than 50 square meters in area are unacceptable in Area 1.

3.13.4.6. Area 2
Data voids due to removal of vegetation that are greater than 100 square meters in area are unacceptable in Area 2.

Careful flight planning should ensure that flight parameters minimize the risk of data voids. The **respondent** should provide a brief description of anticipated data voids, including lessons learned from previous experience and data void issues that may be specific to this project site. NYSERDA expects the LiDAR-derived digital elevation data be as close to 100% clean and free of data voids as possible.

3.13.5. The SDA and NDA Geomembrane Covers

The 15-acre State Licensed Disposal Area (SDA) and 7-acre Nuclear Regulatory Commission Licensed Disposal Area (NDA) are covered by black geomembrane covers (see Attachment E). These covers are purposefully shaped to include ballast areas and storm water management features, and thus are topographically complex. The material comprising the covers varies by section and the age of the sections of the covers is varied.

The **respondent** shall include in their proposal a description of any past experience with LiDAR data collection on dark geomembrane surfaces, their expectations with regards to data quality, and any adjustments or supplements to the flight plan or otherwise that will ensure data collection over the covers will meet all measurement density and accuracy standards for Project Area 1 described herein.

If LiDAR data acquisition is not possible, there are unacceptable data voids, and/or accuracy standards are not met in the area of the geomembrane covers, the **selected contractor** will conduct a supplemental topographic survey (e.g. ground-based laser survey, photogrammetry, etc) and integrate these data with the LiDAR dataset to provide seamless topographic datasets and meet all accuracy standards for Project Area 1, including point measurement density.

3.13.6. Artifacts

Artifacts are regions of anomalous elevations or oscillations and ripples within LiDAR-derived DEM data resulting from systematic errors, environmental conditions, or incomplete post processing. Both automated and manual post-processing methods will be used to remove artifacts and the orthoimagery will aid in manual methods. As removal of artifacts may create data voids, the specifications given in Section 3.13.4 apply.

Where artifacts are not completely removed, or where acceptable data voids exist due to artifact removal, the **selected contractor** shall provide an analysis of the effects of the artifacts on DEM accuracy. The analysis shall include an identification of artifacts, a description of the causes (contributing sources) of the artifacts, and a description of the steps taken to eliminate them.

The **respondent** should provide a brief description of (1) anticipated artifacts, including lessons learned from previous experience and artifact issues that may be specific to this project site and (2) processing methods used to remove artifacts. NYSERDA expects the LiDAR-derived digital elevation data be as close to 100% clean and free of artifacts as possible.

3.13.7. Quality Control (QC)

Process QC is primarily the responsibility of the **selected contractor**. The QC shall involve procedures that check quality during the collection process to reduce the likelihood of having to re-fly portions of the project area. A registered Professional Engineer or Licensed Land Surveyor shall certify topographic data, in accordance with 44CFR 65.5(c). Certification of topographic data by the American Society for Photogrammetry and Remote Sensing is also acceptable. The **selected contractor** must make certifications at (1) the time the preflight deliverables (see section 3.14.1) are submitted and (2) the time the final deliverable products are submitted.

3.13.8. Quality Assurance (QA)

Quality assurance ("quality control of quality control") will involve the establishment of pre-flight surveyed checkpoints to determine the vertical accuracy of the LiDAR datasets. The **selected contractor** shall perform checkpoint surveys to achieve 2-centimeter Local Network accuracy per NGS-58 (see Section 3.11). Checkpoints shall be surveyed using DGPS relative to NSRS monuments that have both Ellipsoid and Vertical Order specified on their NGS data sheets. The selected contractor may use third-order conventional surveys to extend control from GPS "anchor points" to other transaction or cluster points, especially where GPS signals are blocked by heavy forest cover. These test points, which will be used for quality checking, must not be used for ground control per Section 3.11.

The selected contractor shall survey a minimum of 15 test points for the following major vegetation categories for a minimum of 90 test points in total:

3.13.8.1. Bare earth and low grass (e.g. plowed fields, lawns)

3.13.8.2. High grass, weeds, and crops (e.g. meadows, corn fields)

3.13.8.3. Brush lands and low trees (e.g. overgrown meadows, areas of shrubs)

3.13.8.4. Deciduous forest, fully covered by trees (e.g. hardwoods)

3.13.8.5. Evergreen forest, fully covered by trees (e.g. conifers)

3.13.8.6. Urban, developed areas (e.g. WVDP industrial complex, Hamlet of West Valley)

Test points shall be distributed as evenly as practical throughout the Project Areas. Test points will be located in terrain that is flat or uniformly sloped within 5 meters in all directions. The uniform slope will not exceed 20 percent. The test points will be located away from breaklines, such as bridges and embankments. The **selected contractor** shall take photographs to record the location of the checkpoint relative to its surroundings, and to verify the vegetation category within which the checkpoint is located. The **selected contractor** shall mark each checkpoint with a 60D nail or larger. The **selected contractor** shall write the station ID number on an adjacent above-ground stake within 1 foot of the referenced spike, to aid in subsequent recovery if required during the course of the project. The **selected contractor** shall use "to reach" location descriptions and photographs to document the location, the land cover surrounding each stake, and the uniform slope of the terrain surrounding each stake. These activities and shall be documented in test point summary datasheets similar to the example in Attachment H. These data sheets, containing the location (x and y position) in US survey feet referenced to the New York State Plane HARN Coordinate system, West Zone, NAD83 HARN, 2007 adjustment, and the orthometric elevation from an independent source of higher accuracy (referenced to NAVD-88 datum) for all test points, shall be delivered to NYSERDA prior to any data acquisition flights (as outlined in Section 3.14.1.4). A large

scale 1:24,000 map containing all test points shall also be provided pre-flight. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

Confidence in the calculated RMSE value increases with the number of test points. If the errors associated with the digital elevation are normally distributed, the confidence can be calculated as a function of sample size. For each of the six land cover categories, the selected contractor must test a sample of points and show the test points meet the minimum RMSE requirements in Sections 3.13.1 and 3.13.2.

Because the definition and criterion for measuring accuracy are derived from the assumption that the test points come from a uniformly distributed population with zero mean, the **selected contractor** must provide a statistical analysis of observed errors per FEMA's Appendix A, Section A.8.3.6

3.13.9. Error Analysis, Assessment, and Correction

When a LiDAR dataset does not pass horizontal or vertical accuracy standards (see Sections 3.13.1 and 3.13.2), the **selected contractor** must identify the cause of the errors, produce a full statistical analysis of the errors per FEMA's Appendix A, Section A.8.3.6, and inform the NYSERDA project manager that the dataset has deviated from accuracy standards. The **selected contractor** must then furnish NYSERDA with a complete error analysis, per FEMA's Appendix A, including, but not limited to:

3.13.9.7. Assessment by land-cover

3.13.9.8. Assessment by error locations

3.13.9.9. Assessment by dates/sensors

3.13.9.10. Airborne GPS verification

3.13.9.11. Inertial Measurement Unit (IMU) verification

3.13.9.12, Laser range verification

3.13.9.13. Total system verification

No systematic correction should be applied before the source of the error is known and NYSERDA has been made aware of the error. If the **selected contractor** believes that the nature and magnitude of systematic error(s) have been identified and a plan exists to

"correct" the errors, this plan must be submitted in writing to NYSERDA for review by NYSERDA's project manager and Technical Evaluation Panel. Should a consensus disagree that the errors may be "corrected" by systematic adjustment during post processing and/or additional QA/QC methods, a subsequent data acquisition flight mission will be required at no expense to NYSERDA.

3.14. LiDAR Deliverables

3.14.1. Pre-flight submittals

At least seven (7) working days prior to data collection the selected contractor must submit the following information:

3.14.1.1. Flight Path Map
A map (at a large scale of 1:24,000) showing the collection area boundaries and the planned flight paths. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

3.14.1.2. Flight Plan
Documentation specifying altitude, air speed, scan angle, scan rate, LiDAR pulse rates, and all flight equipment information deemed appropriate. All procedures, processes, checklists and PDOP and Kp-index planning documentation shall also be submitted.

3.14.1.3. Flight Schedule
A tentative flight schedule shall be provided. The **selected contractor** shall provide daily verbal updates to the NYSERDA project manager, including updated flight schedules for the upcoming day.

3.14.1.4. Ground Control Plan
The proposed ground control plan including NGS data sheet documentation and established GPS control sites. If necessary, the **selected contractor** shall obtain all Right-of-Entry requirements. Any information that would allow surveyors to tie into the same control for future use shall be included.

3.14.1.5. Surveyed LiDAR Test Points
All documentation supporting surveyed test points to be used for LiDAR accuracy assessment including vertical and horizontal coordinates, land cover descriptions, photographs, and "to reach" descriptions. A large scale 1:24,000 map containing all test points shall also be provided.

3.14.2. Post-Project LiDAR Deliverables

The following shall be delivered no later than 16 weeks from the termination of flight data acquisition.

3.14.2.1. Project Area LiDAR product coverages
LiDAR data products for the two Project Areas shall be delivered as follows:

3.14.2.1.1. Project Area 1
LiDAR Data files for Project Area 1 shall cover Project Area 1 and Project Area 1 buffer as described in Section 3.3 at the resolution/contour interval specified for Project Area 1 (see Section 3.14.2.2) so that a complete tiled dataset be delivered for the entire WNYNSC property and buffer.

3.14.2.1.1. Project Area 2
LiDAR Data files for Project Area 2 shall cover Project Area 2 and Project Area 2 buffer area as described in Section 3.3 at the resolution/contour interval given in Section 3.14.2.2. Data for Project Area 1 shall be resampled/reprocessed at the resolution/contour interval specified for Project Area 2 (see Section 3.14.2.2) and merged with Project Area 2 data so that a complete tiled dataset is delivered for the entire Buttermilk Creek watershed and buffer.

3.14.2.2. Resolution and Contour Interval

The LiDAR data products shall be delivered at the following grid-spacing and contour interval:

3.14.2.2.1. Project Area 1

- Raster-based elevation models
  Shall be delivered at 0.5 m horizontal grid spacing in Easting and Northing.

- Contour Interval
  Contours shall be generated at 1.0 foot contour intervals and must be supported to ASPRS Class 1 standards.

3.14.2.2.2. Project Area 2

- Raster-based elevation models
  Shall be delivered at 1.0 m horizontal grid spacing in Easting and Northing.

- Contour Interval
  Contours shall be generated at 2.0 foot contour intervals and must be supported to ASPRS Class 1 standards.

3.14.2.3. Tiling

- The **respondent** shall propose a tiling format for division of the data into a collection of files. This tiling scheme shall maximize file size while maintaining operability within GIS software on standard desktop hardware (i.e. maximum file size ~500Mb)

- Tiles shall be square.

- If, for a particular dataset, tiling is unnecessary, the entire data file will be delivered as a single seamless file (as is expected with contour data).

- The **respondent** shall provide a large scale (1:24,000) map depicting the proposed tiling scheme. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

- The **selected contractor** shall supply an ESRI polygon shapefile containing all tiles attributed with unique identifiers that will be used as file designators for all datasets employing the tiling scheme.

- Should NYSERDA choose to provide its own tiling scheme prior to the start of the project, the **selected contractor** must abide by NYSERDA's provisions.

3.14.2.4. All Raw Data

All raw (post-calibrated, pre-filtered, fully classified) mass point LiDAR data shall be delivered for all collection returns, including time-stamped latitude, longitude, elevation, and intensity data.

- Horizontal data shall be provided in latitude/longitude decimal degrees to eight (8) digits of precision in the NAD83(07) datum.

- Elevation values (z) shall be provided in integer centimeters with 1 cm resolution in the NAVD88 datum.

- The data shall be provided in both a comma delimited ASCII file and the most current version of the LiDAR Archive Standard (LAS) format. The **respondent** may suggest additional formats.

3.14.2.5. Filtered Bare-Earth Data

Latitude, longitude, and elevation data for filtered raw data that represents the bare Earth. To restrict data to ground elevations only, elevation points on buildings and other structures, and on vegetation shall be removed from the LiDAR point cloud.

- Horizontal data shall be provided in latitude/longitude decimal degrees to eight (8) digits of precision in the NAD83(07) datum.

- Elevation values (z) shall be provided in integer centimeters with 1 cm resolution in the NAVD88 datum.

- The data shall be provided in both a comma delimited ASCII file and the most current version of the LiDAR Archive Standard (LAS) format. The **respondent** may suggest additional formats.

3.14.2.6. Breaklines

Breaklines are linear features that describe a change in the slope, smoothness, or continuity of a surface.

- The **respondent** shall describe a plan for breakline definition. The **respondent** shall indicate their experience and qualifications for this item and should provide sample datasets/illustrations that exemplify their capabilities.

- **The selected contractor** shall produce 3D breaklines that include, but are not limited to stream centerlines, drainage ditches and gullies, tops and bottoms of streambanks, edges of streams, ridge lines, road crowns, dams, bulkheads, embankments, and manmade features that control the flow of water (e.g. curb lines).

- "Soft" breaklines shall ensure that known z-values along a linear feature are maintained.

- "Hard" breaklines shall define interruption in surface smoothness (i.e. locations with abrupt surface changes)

- Breaklines shall be edited manually by stereo photogrammetric procedures

- The **selected contractor** shall specify the source and accuracy of breakline data

- Breakline data shall be delivered in ESRI ArcGIS feature class format. The **respondent** may suggest additional formats.

3.14.2.7. Bare Earth Digital Terrain Model (DTM)

Raster-based DTM derived from the last return LiDAR data; manmade structures and vegetation removed.

- Vertical DTM resolution shall preserve ranging resolution at a minimum of 1 cm, shall be provided in integer centimeters, and shall conform to the NAVD88 vertical datum

- DTM shall be enhanced using breakline data described in Section 3.14.2.6.

- DTM shall be delivered in ESRI GRID format. The **respondent** may suggest additional formats. Each DTM tile shall have corresponding metadata contained in an .xml or .html file.

3.14.2.8. Reflective Digital Surface Model (DSM)

Raster-based DSM derived from the first return LiDAR data.

3.9.2.3.2. Vertical DSM resolution shall preserve ranging resolution at a minimum of 1 cm, shall be provided in integer centimeters, and shall conform to the NAVD88 vertical datum

3.9.2.3.1. DSM flies shall be delivered in ASCII comma delimited and ESRI GRID formats.. The **respondent** may suggest additional formats. Each DSM tile shall have corresponding metadata contained in an .xml or .html file.

3.14.2.9. Hydrologically-Corrected Digital Elevation Model (Hydro-DEM) and breaklines

Raster-based DEM manually edited for hydro-enforcement.

- This DEM shall be edited to represent, to the best of the vendor's ability, the known hydrology of the Project Areas. Anticipated processing requirements may include soft (i.e. algorithm-based approaches) and hard techniques (e.g. "stream burning" or surface reconditioning).

- The **respondent** shall describe a plan for hydro-enforcement editing and should indicate any relevant experience developing Hydro-DEMs, including sample datasets/illustrations. The **respondent** shall indicate their ability to use the proposed LiDAR and stereoimagery to identify small culverts and to "burn" small stream channels through the overlying topography. The **respondent** shall indicate their experience and qualifications for this item and may provide sample datasets/illustrations that exemplify their capabilities.

- As this data will be used primarily for modeling hydrology within very small streams, the primary goal of this Hydro-DEM editing is to "burn" streams through bridges and roadway/driveway/railway culverts and to modify breaklines accordingly. The editing process should not rely on "filling" DEM pits in order to force flow over obstructions, particularly roadways.

- Hydro-DEM-specific breaklines, including breaklines through "burned" culverts (and the drainage ditches leading through them) shall be used to amend the original

breaklines described in section 3.14.2.6 and shall be delivered as a separate file in ESRI ArcGIS feature class format. The respondent may suggest additional formats.

- Vertical Hydro-DEM resolution shall preserve ranging resolution at a minimum of 1 cm, shall be provided in integer centimeters, and shall conform to the NAVD88 vertical datum

- Hydro-DEM shall be enhanced using Hydro-DEM-specific breakline data described above.

- Hydro-DEM flies shall be delivered in ASCII comma delimited and ESRI GRID formats. The **respondent** may suggest additional formats. Each Hydro-DEM tile shall have corresponding metadata contained in an .xml or .html file.

3.14.2.10. Contours

The selected contractor will provide seamless contour datasets for Project Areas 1 and 2.

- The **respondent** shall describe the data processing methods (including photogrammetric, lidargrammetric, automated and manual methods) used to create contours of sufficient quality to meet the guidelines below. The **respondent** shall indicate their experience and qualifications for this item and may provide sample datasets/illustrations that exemplify their capabilities.

- The **respondent** shall describe the process of incorporating breakline data in order for the contours to accurately reflect the ground elevation and slope. The **respondent** shall indicate their experience and qualifications for this item and may provide sample datasets/illustrations that exemplify their capabilities.

- Contours shall be developed from the bare Earth DTM described in Section 3.14.2.7.

- LiDAR point density shall support generation of contours at the prescribed contour interval (see Section 3.14.2.2) to ASPRS Class 1 accuracy standards.

- The contour dataset shall be developed using all appropriate photogrammetric checks and adjustments and shall be enhanced with breakline data described in Section 3.14.2.6.

- Attribution of the contours must, at a minimum, consist of (1) an elevation attribute, (2) an index/intermediate contour attribute and (3) a depression attribute. The **respondent** may recommend additional attribution, if any, and provide sample datasets that illustrate the processing results.

- Contour datasets shall be delivered in ESRI feature class format. **Respondents** may suggest additional formats

3.14.2.11. LiDAR Deliverables Summary

Table 1. Required post-project LiDAR deliverable products, their resolution/contour interval, and delivery format as described above.

Product	Project Area 1 (The entire WNYNSC property and buffer area)	Project Area 2 (The entire Buttermilk Creek watershed and buffer area, including Project Area 1)	Format
Tiling Scheme	Square tiles	Square tiles	ESRI polygon shapefile(s)
All Raw Data	Classified LiDAR Point Cloud	Classified LiDAR Point Cloud	ASCII and LAS
Filtered Bare Earth Data	Filtered LiDAR Point Cloud	Filtered LiDAR Point Cloud	ASCII and LAS
Breaklines	n/a	n/a	ESRI Feature Class
Bare Earth DTM	0.5 m grid	1.0 m grid	ASCII and ESRI grid
Reflective DSM	0.5 m grid	1.0 m grid	ASCII and ESRI grid
Hydro-DEM	0.5 m grid	1.0 m grid	ASCII and ESRI grid
Hydro-Specific Breaklines	n/a	n/a	ESRI Feature Class

Contours	1.0 foot contour interval	2.0 foot contour interval	ESRI Feature Class

3.15 Aerial Photography and Orthoimagery Services

The selected contractor will provide orthorectified, true color, digital imagery for Project Areas 1 and 2.

3.15.1. Allowable Aerial Imagery Acquisition Conditions

Aerial Imagery data will be acquired under the following circumstances:

3.15.1.1 Favorable weather conditions free of rain, snow, fog, mist, high wind gusts, and low clouds, as such conditions have been known to degrade the quality of image data.

3.15.1.2 Sufficiently clear ground conditions free of flood water, snow, and ice.

3.15.1.3 Normal water levels – sufficiently removed in time from events such as storms that may cause temporarily increased water levels in streams and other water bodies and standing or ponding water on other flat surfaces.

3.15.1.4 During “leaf-off” conditions – when the canopy of the deciduous forest is bare and there is no vegetative growth of agricultural crops.

3.15.1.4 During the same “leaf-off” period in which the LiDAR data is collected.

3.15.1.5 When turbulence is less than moderate and cross winds are less than 20 knots.

3.15.1.5 When the sun angle is not less than 40 degrees above the horizon.

3.15.1.4 When cloud shadows will not obscure any part of any photo for Project Area 1.

3.15.1.4 When cloud shadows will not obscure more than 5% of any photo for Project Area 2.

3.15.1.5 When relief/and or sun angle will not cause objectionable shadows.

3.15.1.5 When all possible steps have been taken to minimize spectral reflectance from water so that shoreline features are not obscured.

3.15.2. Sensor and Equipment

Respondents must describe the sensor(s) and related specifications to be used for aerial photography. A digital based "matrix array" digital camera system shall be used. A pushbroom or linear array digital camera system shall not be used. The camera shall be a precision aerial mapping camera equipped with a low distortion, high resolution lens and sensor.

The digital images shall be clear and sharp in detail and of high radiometric quality. The camera shall capture the images in an uncompressed "lossless" format. The camera shall, at a minimum, utilize a 12-bit per pixel radiometric resolution. The images shall be free from blurs, image artifacts, "cold" or "hot" pixels, color distortion, color balance or tonal problems, or any other kind of "digital blemish". All fiducial mark images (if applicable) should be visible, clear, and sharp.

NYSERDA prefers that the **respondent** own all the equipment and own or license all software to be used for the project. This increases the likelihood that the equipment will be properly calibrated and well-maintained.

3.15.3. Camera Calibration

The respondent shall indicate the date(s) of the most recent calibration of camera equipment and the name(s) of the organization conducting the calibration. The absence of up-to-date camera calibration may be cause for disqualification of the respondent.

The **selected contractor** shall provide a camera calibration report (a USGS camera calibration report is preferred), no more than three years old, for each aerial camera to be used. This report will be used to assure that the camera lens, focal length, light filter, shutter, image format, and CCD array are all photographically adequate and within acceptable accuracies.

Both Project Areas will preferably be flown using one type of camera assembly. If the dimensional stability of the camera has been disturbed since its last calibration, the **selected contractor** shall have the camera recalibrated prior to the acquisition of photography. The **selected contractor** will ultimately be responsible for errors caused as a result of incorrect calibration of the camera equipment.

3.15.4. Flight Planning

Planning a flight path that considers all aspects of data collection is critical to the success of the mission. An analysis of the project area, project requirements, topography, and other factors will determine the flight path configuration. The **respondent** and **selected**

contractor shall have the flexibility of providing a flight path to acquire the aerial imagery. Factors that shall be considered when planning the flight include, but are not limited to:

3.15.4.1. Position Dilution of Precision (PDOP)

3.15.4.2. Geomagnetic activity

3.15.4.3. Number of satellites

3.15.4.4. Baseline length

3.15.4.5. Flight altitude

3.15.4.6. Airspeed

3.15.4.7. End lap, side lap, crab, and tilt

Consecutive photos in each flight line shall have an average forward overlap of 60% (±2%) to ensure full stereoscopic coverage. End lap of less than 55% or more than 65% in one or more exposures will be cause for rejection of the flight strip, or a portion thereof.

Side lap between adjacent parallel flight lines shall be a minimum of 30%. Any parallel flight lines having side lap of 25% or less will be rejected and reflown.

Crab in access of 3 degrees measured with respect to both lines of flight may be cause for rejection of a flight strip or any portion thereof in which excess crab occurs. This includes relative crab between any two successive exposures.

Tilt of the camera from vertical at the instant of exposure shall not exceed 3%, nor shall it exceed 5% between successive exposure stations. Average tilt over either Project Area shall not exceed 1%.

The **respondent** shall state the expected values of these factors for both Project Area 1 and Project Area 2 for items 3.15.4.1 to 3.15.4.7 above. The respondent shall prepare a proposed draft flight plan for aerial photography, which will show on a 1:24,000 map, the flight lines to be utilized. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets. Each flight line shall be flown continuously across the Project Areas. The principal points (which do not need to be supplied as part of this proposal) of the first two (2) and last two (2) frames of each flight shall fall outside the buffer areas for each Project Area, and all buffer area outer boundaries shall be

covered by a minimum of 25% of the photo frame. This preliminary flight plan shall be submitted as part of this proposal.

The **selected contractor** shall provide a final accepted flight plan submitted in ArcGIS Personal Database format to NYSERDA as a final deliverable product (see Section 3.17.2.2).

3.16. Aerial Photography and Orthoimagery Performance Standards

The **selected contractor** shall furnish all necessary materials and equipment and shall also supply the supervisory, professional, and technical services personnel required to manage, survey, document, and process all the data associated with aerial photography, digital processing, and orthorectification. The **respondent** shall propose to furnish all deliverables as outlined in this RFP.

3.16.1. Scale and Resolution: Project Area 1

Natural color aerial photography shall be obtained at the appropriate scale to produce color digital orthoimagery with a ground pixel size of a maximum of 3” (0.25’). These specifications will follow the ASPRS Class 1 standards for a 1’=50’ map scale and shall have a pixel size of 3” (0.25’) and an RMSE (planimetric) of less than 6” (0.5’). Pixel resolution shall never be interpolated to a finer resolution than that developed through the original digital camera exposure. The orthoimagery will be produced using the concurrent LiDAR DSM.

3.16.2. Scale and Resolution: Project Area 2

Natural color aerial photography shall be obtained at the appropriate scale to produce color digital orthoimagery with a ground pixel size of a maximum of 6” (0.5’). These specifications will follow the ASPRS Class 1 standards for a 1’=100’ map scale and shall have a pixel size of 6” (0.5’) and an RMSE (planimetric) of less than 1.0’. Pixel resolution shall never be interpolated to a finer resolution than that developed through the original digital camera exposure. The orthoimagery will be produced using the concurrent LiDAR data.

Due to the shape and configuration of the Project Areas, the respondent may propose a flight plan than extends the higher resolution photography beyond the boundary of the Project 1 Buffer Area. This is considered acceptable.

3.16.3 Ground Control

Ground control standards discussed in Section 3.11 apply. To the degree that LiDAR test points developed per Section 3.13.8 are applicable, they may be used for photo control. The respondent shall provide a discussion and description of planned photo control, including the dependence on control points that have not been surveyed.

All orthoimagery shall be tied to the New York State Plane West Coordinates, NAD83(07) and NAVD88.

A control report (detailed in Section 3.18.1.3) will be a required post-project deliverable.

3.16.4. Analytical Aerotriangulation

Analytical Aerotriangulation must be used to densify ground control in support of NYSERDA's specified orthophotography requirements for each Project Area. Industry standard methods, procedures, and software shall be used to ensure the positional accuracy of the derived points to ASPRS Class 1 specifications for orthophotography guidelines detailed in Sections 3.16.1 and 3.16.2.

The **respondent** shall include a description of the the triangulation production process and the quality control measures to be implemented. Upon completion of the analytical aerotriangulation, the **selected contractor** shall produce a report that includes residuals, computed coordinates, and software used.

3.16.5. Digital Orthorectified Image Characteristics

Relative join (misalignment) of transportation features between adjacent image tiles shall not exceed 3 pixels. Orthophotos shall be tonally balanced to produce a uniform contrast and tone across the image tiles of the entire project. Changes in color balance across the project, if they exist should be gradual. Abrupt tonal variations between tiles are not acceptable. Ground features appearing in the orthoimagery, such as building rooftops, towers and chimneys, etc. shall not be clipped at seamlines or between individual tiles. Image artifacts introduced during image processing are unacceptable.

3.16.6. Quality Control and Quality Assurance

The selected contractor shall make every effort to ensure all processes and procedures used meet the specifications of this RFP. Any deviation from the specifications herein is grounds for NYSERDA's refusal of any or all aerial photography and orthoimagery products. Any required re-flights will be conducted in a timely manner (during the same or next "leaf-off" period) at no cost to NYSERDA. The selected contractor shall inspect the orthoimagery for the following before delivery:

3.16.6.1. Atmospheric artifacts
Cloud cover, smoke, and haze shall be absent from all imagery.

3.16.6.2. Misalignment
Excessive horizontal displacement relative join (misalignment) of transportation features between adjacent image tiles or seamlines shall not exceed 3 pixels.

3.16.6.3. Tonal Balance
Orthophotos shall be tonally balanced to produce uniform contrast and tone across the block and the entire project. Extreme tonal or color variation across seamlines will be avoided. Changes in color balance across the Project Areas, should they exist, shall be gradual. Abrupt tonal variations between tiles or inconsistencies in tone and density between individual orthophotos and/or adjacent sheets are not acceptable.

3.16.6.4. Building tilt
Excessive tilt in bridges, buildings, and other raised structures shall be corrected particularly to the extent that they obscure transportation features and/or watercourses. Bridges should be raised to deck level.

3.16.6.5. Clipping
Features such as towers, chimneys, buildings and similar shall not be clipped at tile boundaries or seamlines.

3.16.6.6. Image mosaicing/tiling and quality
The image with the best contrast shall be used as a reference image when color digital orthophoto tiles are created. All other images shall have their brightness values adjusted to that of the reference image.

3.16.6.7. Image artifacts
The delivered color digital orthophotos will not contain defects such as out-of-focus imagery, blurs, whorls, twists, or color blemishes. The images shall be free of smears, voids, color distortion, color balance or tonal problems, or any other kind of “digital blemish” or data corruption. All fiducial mark images in the raw photography (where applicable) shall be visible, clear, and sharp. Evidence of oversaturation or undersaturation as a result of image processing or histogram manipulation shall be avoided.

3.16.6.8. Evidence of image compression
Images should not be unnecessarily compressed at any stage of production. Artifacts due to image compression shall be absent.

3.16.6.9. Building/structure warp
Any warp of buildings or structures, an indication of bad elevation data shall be minimized. Bridges should be raised to deck level.

3.16.6.10. Completeness
Data are to cover the specified geographic extent (see Section 3.3 and Attachment D) and are to be free of omissions or corrupt data.

3.17. Aerial Photography and Orthoimagery Deliverables

3.17.1. Pre-flight submittals

At least seven (7) working days prior to data collection the **selected contractor** must submit the following information:

3.17.1.1. Flight Path Map
A map (at a large scale of 1:24,000) showing the collection area boundaries and the planned flight paths. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

3.17.1.2. Flight Plan
Documentation specifying altitude, air speed, and all flight equipment information deemed appropriate. All procedures, processes, checklists and PDOP and Kp-index planning documentation shall also be submitted.

3.17.1.3. Flight Schedule
A tentative flight schedule for aerial photography. The **selected contractor** shall provide daily verbal updates to the NYSERDA project manager, including updated flight schedules for the upcoming day.

3.17.1.4. Ground Control Plan
The proposed ground control plan to be used for image processing including NGS data sheet documentation and established GPS control sites. If necessary, the **selected contractor** shall obtain all Right-of-Entry requirements. Any information that would allow surveyors to tie into the same control for future use shall be included.

3.17.1.5. Surveyed Imagery Test Points
All documentation supporting surveyed test points to be used for imagery accuracy assessment including vertical and horizontal coordinates, land cover descriptions, photographs, and “to reach” descriptions. A large scale 1:24,000

map containing all test points shall also be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

3.17.2. Post-Project Aerial Photography and Orthoimagery Deliverables

The following shall be delivered no later than 16 weeks from the termination of flight data acquisition.

3.17.2.1. Tiling Scheme

The **respondent** shall propose a tiling format for division of the data into a collection of files. This tiling scheme shall maximize file size while maintaining operability within GIS software on standard desktop hardware (i.e. maximum single file size ~500 Mb). Tiles shall be square.

The **respondent** shall provide a large scale (1:24,000) map depicting the proposed tiling scheme. This map shall be supplied in both hard- and soft-copy formats. Soft-copy shall be suitable for use in ArcGIS and should be projected to the same spatial reference as the final deliverable datasets.

The **selected contractor** shall supply a separate ESRI polygon shapefile containing all tiles attributed with unique identifiers that will be used as file designators for all datasets employing the tiling scheme. Should NYSERDA choose to provide its own tiling scheme, the **selected contractor** must abide by NYSERDA's provisions.

3.17.2.2. Digital Flight Plan

The **selected** contractor shall submit final accepted flight plan(s) for Project Area 1 and Project Area 2 in ArcGIS Personal Geodatabase format. In this digital flight plan, a point shall be digitized to represent the principal point of each individual photographic frame. The attribute table of the principal points shall indicate a unique ID for each point, the frame ID, the flight line number to which the frame belongs, the starting and ending flight line segments to which the frame belongs, the state plane coordinates of the principal point of the photo frame, the 3D (airborne GPS) coordinates of the sensing platform at the time of frame exposure, and the attitude (roll, pitch, and yaw angles) of the sensing platform at the time of frame exposure.

Each flight line shall be digitized as a chain of individual line segments representing the flight line segments connecting the principal points of the

consecutive photo frames. Each flight line shall be digitized in the order and direction the frames were flown. The attribute table of the flight line segments shall include a unique ID for each segment, the flight line number to which the segment belongs, the IDs of the "from" and "to" principal points defining the segment, and the straight line (planar) distance of each segment in feet. Unacceptable aerial photography shall be reflown at no cost to NYSERDA, with the reflight coverage overlapping the accepted photography by at least two stereo models. This digital flight plan shall then be amended with the reflown flight lines, principal points, etc.

This digital flight plan shall also include an index-sheet polygon shapefile representing the tiling scheme (specified above) used for orthophoto division and delivery. The attribute table for the polygon shapefile shall include, at a minimum, a unique ID for each tile, the ID of all digital frames contributing data to the tile, and the coordinate boundaries of the tile in all four cardinal directions.

This digital flight plan shall also include a point shapefile containing all control points. The attribute table for the point shapefile shall include, at a minimum, a unique ID for each point, the x,y, and z coordinates of each point, and where applicable, the ground cover classification for each point.

3.17.2.3. Digital Frames

Digital photo frames will be prepared from each of the original digital exposures. These unrectified digital frames shall be in an uncompressed TIFF image format containing the full radiometric pixel values for all wavelengths collected. Frames should follow the naming convention for photo locations identified in the final digital flight plan.

3.17.2.4. Digital Orthorectified Imagery

Digital orthorectified images shall be produced at the resolution specified for Project Area 1 and Project Area 2 in Sections 3.16.1 and 3.16.2. Orthoimages are to be fully georeferenced and referenced horizontally to the New York State Plane Coordinate System NAD83(07). Pixel resolution shall never be interpolated to a finer resolution than that developed through the original digital camera exposure. Orthoimagery will be tiled according to the tile index information provided by the selected contractor and contained in the digital flight plan (Section 3.17.2.2).

A complete set of orthorectified imagery tiles shall be submitted in uncompressed ArcGIS readable, GeoTIFF file format. Two (2) MrSID files should be compiled; one each for Project Area 1 and Project Area 2,

each containing all orthoimagery for the respective Project Area. Metadata standards specified in Section 3.2 shall be followed. Each orthorectified image tile shall have corresponding metadata contained in an .xml or .html file.

3.17.2.5. Mapbooks

The selected contractor shall furnish two (2) copies of a compilation of 36”x36” mapbook sheets on high-quality photographic paper displaying the color orthophoto at 1”= 50’ for Project Area 1 and its buffer area. Where visible on any particular mapbook sheet, the WNYNSC property boundary (as provided in Shapefile format by NYSERDA) shall be denoted as a solid red line 1/8” in thickness. Mapbook sheets shall be complete with margin “to sheet” references on all edges for which a neighboring mapbook sheet exists. Mapbook sheet margins shall have a North arrow and scale bar in feet and the date of imagery collection shall be specified on all sheets.

Product	Project Area 1 (The entire WNYNSC property and buffer area)	Project Area 2 (The balance of the Buttermilk Creek Watershed not contained within Project Area 1)	Format
Tiling Scheme	Square tiles	Square tiles	ESRI polygon shapefile(s)
Digital Flightplan	Principal points, flight lines, tiles, control points, etc.	Principal points, flight lines, tiles, control points, etc.	Personal Geodatabase
All Digital Frames	All raw images	All raw images	Uncompressed TIFF
Digital Orthoimagery	0.25’ pixel	0.5’ pixel	MrSID & GeoTIFF
Mapbooks	36” x 36” photo sheets	none	Printed sheets

3.18. Project Completion

3.18.1. Project Completion Report

Upon completion of the project (no later than 16 weeks after the termination of mission flights) all data products and reports shall be delivered to the NYSERDA project manager.

3.18.1.1. LiDAR Report
Discuss data processing methods used, final LiDAR pulse and scan rates, scan angle, side overlap, swath width, line spacing, capabilities for multiple returns from a single pulse, accuracy and precision of LiDAR data acquired, accuracy of the topographic surface products, and any other data deemed appropriate. The report shall also include a digital spatial index showing the orientation and location of all data tiles within Project Area 1 and Project Area 2 with tile labels corresponding to the DVD or hard disk media and the designated file name(s). All pertinent checklists and log sheets shall also be included. This report shall include a system calibration report.

3.18.1.2. Digital Aerial Photography and Orthoimagery Report
Discuss data processing methods used, final aerial imagery specifications including end lap, side lap, crab, and tilt. Horizontal accuracy of orthoimagery products, and any other data deemed appropriate. The report shall also include a digital spatial index showing the orientation and location of all data tiles within Project Area 1 and Project Area 2 with tile labels corresponding to the DVD or hard disk media and the designated file name(s). All pertinent checklists and log sheets shall also be included. This report shall include a system calibration report.

3.18.1.3. Ground Control Report
This report shall include, at a minimum, all pertinent base station and test point information. This report shall contain a data sheet for all base stations and test points similar to the example in Attachment H. This report shall include the ellipsoid and geoid models used as part of the collection, and any survey methods and/or practices that would be useful to surveyors repeating the project.

3.18.2. Delivery of Digital Data

Two (2) copies of all digital datasets and digital copies of all reports are to be delivered. One copy shall consist of a set of DVDs, each properly labeled. A second copy shall be stored on a USB2.0 external hard disk drive.

3.18.3. Acceptance

If the finished items are found to be in full compliance with the specifications, they will be accepted. The acceptance of any item by NYSERDA shall not preclude subsequent rejection if such an item is later found to be defective. All media storage hardware shall become the property of NYSERDA upon delivery.

3.18.4. Rights

NYSERDA shall maintain all rights to all deliverables, the resulting data and data distribution.

4.0. Proposal Evaluation and Selection Criteria

NYSERDA will use the following criteria to evaluate the RFP proposals. This is not a comprehensive list, nor does the arrangement imply order of importance.

4.1. Compliance with RFP instructions

The proposal will be evaluated for compliance with the instructions set forth in this RFP. Non-compliance may be grounds for disqualification.

4.2. Quality of Proposal

The proposal will be evaluated for quality, which demonstrates an understanding of the work required to meet the scope of this RFP

4.3. Technical Expertise

The proposal will be evaluated on the **respondent's** demonstrated technical ability. Specific expertise in the areas of LiDAR and orthophotography will be evaluated, including data post-processing expertise.

4.4. LiDAR and Camera Systems

The proposal will be evaluated on the specifications of the equipment the **respondent** will use to complete the work.

4.5. Quality Control

The proposal will be evaluated on the basis of apparent effectiveness of the **respondent's** quality control procedures.

4.6. Staff Qualifications

The proposal will be evaluated on the basis of the **respondent's** demonstrated staff qualifications.

4.7. Similar Project Experience

The proposal will be evaluated on the basis of similar project experience. Technical nature, complexity, size, and time frame will be considered.

4.8. Subcontracting

No portion of this work to be awarded under this contract shall be sublet, assigned, or otherwise disposed of, except with the written consent of NYSERDA. Consent to sublet, assign, or otherwise dispose of any portion of the work performed under this contract shall not be construed to relieve the selected contractor of any responsibility for the fulfillment of this contract. NYSERDA prefers not more than 10% of the work to be subcontracted.

4.9. Organization

The proposal will be evaluated according to the perceived quality of the **respondent's** project organization and management, including staffing, management control, and use of subcontractors.

4.10. Delivery Schedule

The proposal will be evaluated on the basis of the **respondent's** apparent ability to deliver the proposed products and services to NYSERDA in a timely manner. The respondent's production capability will also be evaluated.

4.11. Costs

The proposal will be evaluated on the basis of costs relative to the most responsive, responsible proposal.

4.12. Example datasets

The proposal will be evaluated for the ability of the **respondent** to provide quality example digital datasets (viewable in ArcGIS) that represent the planned resolution/accuracy of this project. Respondents may submit CDs or DVDs containing these digital datasets. Respondents may also include self-explanatory Powerpoint presentations that illustrate example data.

5.0. General Conditions

5.1 Proprietary Information

Careful consideration should be given before confidential information is submitted to NYSERDA as part of your proposal. Review should include whether it is critical for evaluating a proposal, and whether general, non-confidential information, may be adequate for review purposes. The NYS Freedom of Information Law, Public Officers law, Article 6, provides for public access to information NYSERDA possesses. Public Officers Law, Section 87(2)(d) provides for exceptions to disclosure for records or portions thereof that "are trade secrets or are submitted to an agency by a commercial enterprise or derived from information obtained from a commercial enterprise and which if disclosed would cause substantial injury to the competitive position of the subject enterprise." Information submitted to NYSERDA that the proposer wishes to have treated as proprietary, and confidential trade secret information, should be identified and labeled "Confidential" or "Proprietary" on each page at the time of disclosure. This information should include a written request to exempt it from disclosure, including a written statement of the reasons why the information should be exempted. See Public Officers Law, Section 89(5) and the procedures set forth in 21 NYCRR Part 501 www.nyserda.org/nyserda.regulations.pdf. However, NYSERDA cannot guarantee the confidentiality of any information submitted.

5.2 Omnibus Procurement Act of 1992

It is the policy of New York State to maximize opportunities for the participation of New York State business enterprises, including minority- and women-owned business enterprises, as bidders, subcontractors, and suppliers on its procurement Agreements.

Information on the availability of New York subcontractors and suppliers is available from:

Empire State Development
Division For Small Business
30 South Pearl Street

Albany, NY 12245

A directory of certified minority- and women-owned business enterprises is available from:

Empire State Development
Minority and Women's Business Development Division
30 South Pearl Street
Albany, NY 12245

5.3. State Finance Law sections 139-j and 139-k

NYSERDA is required to comply with State Finance Law sections 139-j and 139-k. These provisions contain procurement lobbying requirements which can be found at http://www.ogs.state.ny.us/aboutogs/regulations/advisoryCouncil/StatutoryReferences.html
The attached Proposal Checklist calls for a signature certifying that the proposer will comply with State Finance Law sections 139-j and 139-k and the Disclosure of Prior Findings of Non-responsibility form includes a disclosure statement regarding whether the proposer has been found non-responsible under section 139-j of the State Finance Law within the previous four years.

5.4. Tax Law Section 5-a

NYSERDA is required to comply with the provisions of Tax Law Section 5-a, which requires a prospective contractor, prior to entering an agreement with NYSERDA having a value in excess of $100,000, to certify to the Department of Taxation and Finance (the "Department") whether the contractor, its affiliates, its subcontractors and the affiliates of its subcontractors have registered with the Department to collect New York State and local sales and compensating use taxes. The Department has created a form to allow a prospective contractor to readily make such certification. *See,* ST-220-TD (available at http://www.nystax.gov/pdf/2007/fillin/st/st220td_507_fill_in.pdf). Prior to contracting with NYSERDA, the prospective contractor must also certify to NYSERDA whether it has filed such certification with the Department. The Department has created a second form that must be completed by a prospective contractor prior to contacting and filed with NYSERDA. *See,* ST-220-CA (available at http://www.nystax.gov/pdf/2007/fillin/st/st220ca_507_fill_in.pdf). The Department has developed guidance for contractors which is available at http://www.tax.state.ny.us/pdf/publications/sales/pub223_606.pdf.

5.5. Contract Award

NYSERDA anticipates making one award under this solicitation. It may award a contract based on initial applications without discussion, or following limited discussion or negotiations pertaining to the Statement of Work. Each offer should be submitted using the most favorable cost and technical terms. NYSERDA may request additional data or material to support applications. NYSERDA will use the Sample Agreement to contract successful proposals. NYSERDA reserves the right to limit any negotiations to exceptions to standard terms and conditions in the Sample Agreement to those specifically identified in the submitted proposal. NYSERDA expects to notify proposers in approximately 3 weeks from the proposal due date whether your proposal has been selected to receive an award.

5.6. Limitation

This solicitation does not commit NYSERDA to award a contract, pay any costs incurred in preparing a proposal, or to procure or contract for services or supplies. NYSERDA reserves the right to accept or reject any or all proposals received, to negotiate with all qualified sources, or to cancel in part or in its entirety the solicitation when it is in NYSERDA's best interest. NYSERDA reserves the right to reject proposals based on the nature and number of any exceptions taken to the standard terms and conditions of the Sample Agreement.

5.7. Disclosure Requirement

The proposer shall disclose any indictment for any alleged felony, or any conviction for a felony within the past five years, under the laws of the United States or any state or territory of the United States, and shall describe circumstances for each. When a proposer is an association, partnership, corporation, or other organization, this disclosure requirement includes the organization and its officers, partners, and directors or members of any similarly governing body. If an indictment or conviction should come to the attention of NYSERDA after the award of a contract, NYSERDA may exercise its stop-work right pending further investigation, or terminate the agreement; the contractor may be subject to penalties for violation of any law which may apply in the particular circumstances. Proposers must also disclose if they have ever been debarred or suspended by any agency of the U.S. Government or the New York State Department of Labor.

6.0. List of Attachments

6.1. Attachment A – RFP Checklist

6.2. Attachment B – Disclosure of Prior Findings of Non-Responsibility Form

6.3. Attachment C – Contract Pricing Proposal Instructions Form

6.4. Attachment D – Project Areas 1 & 2, Including Buffer Areas

6.5. Attachment E -- The West Valley Demonstration Project (WVDP) industrial complex, the State Licensed Disposal Area (SDA), and the Nuclear Regulatory Commission Licensed Disposal Area (NDA) property boundaries

6.6. Attachment F – The 2001 National Land Cover Dataset for Project Areas 1 & 2

6.7. Attachment G – Geodetic Control Points

6.8. Attachment H – Example Ground Control/Test Point Datasheet

6.9. Attachment I – Sample Agreement