SECTION C: DESCRIPTIONS AND SPECIFICATIONS

The following **Section C** additional requirements are applicable to this Task Order:

C.1. **SCOPE OF WORK (SOW):** Reference C.1 of the Contract. This task order is for the planning, acquisition, processing, and derivative products of lidar data to be collected at an aggregate nominal pulse spacing (ANPS) of ≤0.35 meters (8 ppsm) for the western portion of Utah (~380 sq mi), including overlap, and ≤0.71 meters for the remainder of the AOI (~4,313 sq mi), including overlap. Lidar data and derivative products produced in compliance with this task order are based on the ***"National Geospatial Program Lidar Base Specification Version 1.3",*** which are incorporated by reference to this task order. This specification may be viewed at ***https://doi.org/10.3133/tm11B4.*** These lidar specifications are required baseline specifications. In addition to the requirements listed below, variations from the specifications will be shown and noted below. For any item which is not specifically addressed, the referenced Version 1.3 specifications will be the required specification authority.

This task order requests a spring 2018 lidar survey to be collected over one (1) distinct Area of Interest (AOI) in northeastern Utah identified as Uintah_Heber. The AOI covers approximately 4693 square miles in total and covers the partial counties of Summit, Utah, Salt Lake, Wasatch, Duchesne, Uintah, Daggett and Moffat (Colorado). The project AOI has been expanded to the Albers National Indexing Scheme - https://pubs.usgs.gov/fs/2017/3073/fs20173073.pdf. Tile index download - https://nationalmap.gov/3DEP/3dep_national_indexing_scheme.html. This project will support the 3D Elevation Program (3DEP) mission, the Federal Emergency Management Agency (FEMA) Risk Mapping, Assessment and Planning (MAP) program and the State of Utah, Automated Geographic Reference Center (AGRC) and its partners. The Defined Project Area (DPA) and associated AOIs are delineated in "Attachment A" and are further defined in "Attachment B." The final, approved delivery diagram will be delineated in "Attachment C" of the executed task order. **This task order covers approximately 380 square miles of QL1 data and approximately 4,313 square miles of QL2 data.** This project will require hydro-flattening.

C.1.a. **KICK-OFF MEETING:** A kick-off meeting shall be held to outline communication procedures that shall be followed for data acquisition with respect to verification of local ground conditions and vegetation requirements. This meeting shall be used as a forum to clarify and resolve collection condition issues. Local contact(s) shall be established, (if requested), to provide ground condition updates. The kick-off meeting shall be held after contract award, but no later than **two (2) weeks** prior to onset of data acquisition.

C.1.b.   **DATA ACQUISITION (COLLECTION):** The contractor shall be responsible for acquisition of lidar data of sufficient density and quality to meet the requirements specified in **the referenced Version 1.3 Lidar Base Specification**, except where explicitly stipulated in this contract:

C.1.b.(i)   **Collection area**: The collection area shall be defined as the Defined Project Area, buffered by no less than 100-meters. The Project Area is defined in **"Attachment A – Project Description and Diagram"** and further delineated by the ESRI ArcShape file included as **"Attachment B – Shape File(s)"**

C.1.b.(ii)   **Aggregate Nominal Pulse Spacing:** Aggregate Nominal Pulse Spacing (ANPS) shall be no greater than 0.35 meters for the **QL1** portion of the AOI and Aggregate Nominal Pulse Spacing (ANPS) shall be no greater than 0.71 meters for the **QL2** portion of the AOI; assessment to be made against single swath, first return data located within the geometrically usable center portion (typically ~95%) of each swath.

C.1.b.(iii)   **Aggregate Nominal Pulse Density:** Aggregate Nominal Pulse Density (ANPD) shall be no less than 8 points per square meter for the **QL1** portion of the AOI and Aggregate Nominal Pulse Density (ANPD) shall be no less than 2 points per square meter for the **QL2** portion of the AOI.

C.1.b.(iv)   **Signal Returns** The laser system shall be configured to collect multiple echoes per pulse, with a minimum of a first return and a last return and at least one additional intermediate return. All returns captured during acquisition shall be delivered. Return number shall be recorded.

C.1.b.(v)   **GPS Times:** shall be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each return. Adjusted GPS Time is defined to be Standard (or satellite) GPS time minus $1*10^9$. See the LAS Specification for more detail.

C.1.b.(vi)   **Signal Strength:** The signal strength (intensity) of each return pulse shall be recorded.

C.1.b.(vii)   **Clustering:** The spatial distribution of geometrically usable points is expected to be uniform and free from clustering. In order to ensure uniform densities throughout the data set:

C.1.b.(vii)(a)   A regular grid, with cell size equal to the design 2*ANPS will be laid over the data.

C.1.b.(vii)(b)   At least 90% of the cells in the grid shall contain at least 1 lidar point.

C.1.b.(vii)(c)   Clustering will be tested against the 1st return only data of points located in the geometrically usable center part (typically 95%) of each swath.

C.1.b.(vii)(d)   Acceptable data voids identified elsewhere in this task order are excluded.

C.1.b.(viii)   **Control:** Lidar shall be acquired using the following control specifications.

C.1.b.(viii)(a)   **Supplemental Ground Control**: Differentially corrected GPS Ground Control used to supplement the Airborne GPS positional accuracy.

C.1.b.(viii)(b)   **Quality Check points**: The Contractor shall collect additional Ground Control Check Points in each project area which shall be delivered in ESRI Arc Shape format and will be used by the Government for validation.

        (01)   Positional Accuracy Standards for Digital Geospatial Data (American Society for Photogrammetry and Remote Sensing [ASPRS], 2014) http://www.asprs.org/a/society/committees/standards/ASPRS_Positional_Accuracy_Standards_Edition1_Version100_November2014.pdf should be consulted to determine the minimum number of checkpoints required. The quantity of checkpoints is linked to the size of the project's AOI. Adherence to the ASPRS recommendations is required, but in no case shall a non-vegetated vertical Accuracy (NVA) be based on less than 20 check points.

        (02)   All check points shall be located in the Defined Project Area (DPA).

        (03)   The ASPRS-recommended distribution of total number of check points between NVA and Vegetated Vertical Accuracy (VVA) assessments shall be met and checkpoints within each type shall be well-distributed across the entire project. Within each assessment type, check points will be distributed among all constituent land cover types in approximate proportion to the areas of those land cover types.

        (04)   Checkpoints for NVA assessments shall be located only in clear, open terrain, where there is a high probability that the sensor will have detected the ground surface without

influence from surrounding vegetation (single return only, away from objects of low reflectivity). Ground that has been plowed or disturbed is not acceptable.

(05) The same check points may be used for NVA assessment of the point cloud and DEM.

(06) VVA points should have survey areas sized with a minimum homogeneous area of (ANPSx5)², with less than one-third of the required $RMSE_z$ deviation from a low-slope (less than 10 degrees) plane.

(07) The checkpoint accuracy shall be 3 times the targeted accuracy of the lidar data.

(08) NVA and VVA are typically comprised of the following land cover categories (but not limited to):

> NVA: Bare Earth/Open Terrain and Urban
> VVA: Tall Weeds/Crops, Brush lands and Trees, and Forested and Fully Grown

(09) Check points shall not be incorporated into the contractor's vertical solution.

C.1.b.(ix) **Vertical Accuracy Requirements:** Absolute vertical accuracy of the lidar data and the derived digital elevation model (DEM) shall be assessed and reported in accordance with ASPRS (2014). Lidar collected under this task order shall meet or exceed these vertical accuracies.

> $RMSE_Z \le 10$ cm (non-vegetated, Swath, DEM)
> NVA $\le$ 19.6 cm 95% Confidence Level (unclassified point cloud, DEM)
> VVA $\le$ 30 cm 95th Percentile (DEM)

C.1.b.(x) **Positional Accuracy Validation:** The absolute and relative accuracy of the data, both horizontal and vertical, relative to known control, shall be verified <u>prior</u> to classification and subsequent product development. A detailed report of this validation is a required deliverable.

C.1.b.(xi) **Absolute Horizontal Accuracy:** The horizontal accuracy of each lidar project shall be reported using the form specified by the ASPRS (2014):

> "This data set was produced to meet ASPRS "Positional Accuracy Standards for Digital Geospatial Data" (2014) for a ___(cm) RMSEx / RMSEy Horizontal Accuracy Class which equates to Positional Horizontal Accuracy =+/- ___cm at a 95% confidence level."

C.1.b.(xii)   **Relative Vertical Accuracy Requirements:** Relative accuracy shall be $\leq$ 6cm within individual swaths (smooth surface repeatability) and $\leq$ 8 cm $RMSD_z$ within swath overlap (between adjacent swaths).

C.1.b.(xiii)   **Acquisition Window:** Acquisition window shall be at a period of annual minimal water level in the **spring 2018** leaf-off window running through **August 30, 2018.** With USGS authorization and as mutually agreed, the contractor may extend the window based on weather, ground and vegetation conditions.

C.1.b.(xiv)   **Overlap:** Flight line overlap is at the contractor's discretion, but is cautioned to be vigorous to ensure there are no data gaps between the usable portions of the swaths and to ensure the aggregate nominal pulse density (ANPD) can be achieved. Collections in high relief terrain are expected to require greater overlap. Any data with gaps between the geometrically usable portions of the swaths will be rejected.

C.1.b.(xv)   **Data Voids:** Data Voids [areas $=>$ $(4*ANPS)^2$, measured using 1st-returns only] within a single swath are not acceptable, except:

C.1.b.(xv)(a)   where caused by water bodies;

C.1.b.(xv)(b)   where caused by areas of low near infra-red (NIR) reflectivity such as asphalt or composition roofing;

C.1.b.(xv)(c)   where caused by lidar shadowing from buildings or other features; or

C.1.b.(xv)(d)   where appropriately filled-in by another swath.

C.1.b.(xvi)   **Data Acquisition Conditions:**

C.1.b.(xvi)(a)   **Atmospheric**: Cloud and fog-free between the aircraft and ground

C.1.b.(xvi)(b)   **Ground**:
(01)   Snow free;

(02)   No unusual flooding or inundation, except in cases where the goal of the collection is to map the inundation.

C.1.b.(xvi)(c)   **Vegetation**: Leaf-off is preferred, however:

(01)   As numerous factors will affect vegetative condition at the time of any collection, the USGS National Geospatial Program (NGP) only requires that penetration to the ground

must be adequate to produce an accurate and reliable bare-earth surface suitable for incorporation into the 3DEP 1-meter product holdings.

(02)   Collections for specific scientific research projects may be exempted from this requirement, with prior approval.

C.1.b.(xvii)   **Time of Day:** Time of day is not of concern.

C.1.c.   **DATA PROCESSING AND HANDLING:** The contractor shall be responsible for post processing of lidar data of sufficient density and quality to meet the requirements specified in **the referenced *"National Geospatial Program Lidar Base Specification Version 1.3***, except where allowances are explicitly stipulated in this Task Order. All processing should be carried out with the understanding that all point deliverables are required to be in fully compliant LAS format, v1.4 (PRF 6-10). Data producers are encouraged to review the LAS specification in detail. Specifications of the LAS data sets will be verified.

C.1.c.(i)   **ACCURACY REPORTING**

C.1.c.(i)(a)   **Data Accuracy:** Data collected under this Task Order shall meet the National Standard for Spatial Database Accuracy (NSSDA) accuracy standards. The NSSDA standards specify that vertical accuracy be reported at the 95 percent confidence level for data tested by an independent source of higher accuracy. For example the metadata statement shall read, "Tested __ (meters, feet) vertical accuracy at 95 percent confidence level."

(01)   **Accuracy of the Lidar Point Cloud Data:** The Non-Vegetated Vertical Accuracy (NVA) of the Lidar Point Cloud data shall be calculated against TINs derived from the final calibrated and controlled swath data. The required accuracy (ACC_Z) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on $RMSE_z$ of 10 cm in the "open terrain" and/or "Urban" land cover categories. This is a required accuracy.

(02)   **Accuracy of the Derived DEM:** The accuracy (ACC_Z) of the derived DEM shall be calculated and reported in three (3) ways:

- **$RMSE_z$ (Non-Vegetated):** The required $RMSE_z$ is: ≤10 cm.
- **Non-Vegetated Vertical Accuracy (NVA)** The required NVA is: ≤19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on $RMSE_z$ of

10 cm in the "open terrain" and/or "Urban" land cover categories. This is a required accuracy.

- **Vegetated Vertical Accuracy (VVA):** The required VVA is: ≤30 cm at a 95th percentile level, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for Lidar Data, i.e., based on the 95th percentile error in Vegetated land cover categories combined (Tall Grass, Brush, Forested Areas). This is a required accuracy.

C.1.c.(ii)   **Hydro Flattening Requirements:**

C.1.c.(ii)(a)   **Inland Ponds and Lakes**:
  (01)   ~2-acre or greater surface area (~350' diameter for a round pond)
  (02)   Flat and level water bodies (single elevation for every bank vertex defining a given water body).
  (03)   The entire water surface edge must be at or just below the immediately surrounding terrain.
  (04)   Long impoundments such as reservoirs, inlets, and fjords, whose water surface elevations drop when moving downstream, should be treated as rivers.

C.1.c.(ii)(b)   **Inland Streams and Rivers**:
  (01)   100' **nominal** width: This should not unnecessarily break a stream or river into multiple segments. At times it may squeeze slightly below 100' for short segments. Data producers should use their best professional judgment.
  (02)   Flat and level bank-to-bank (perpendicular to the apparent flow centerline); gradient to follow the immediately surrounding terrain.
  (03)   The entire water surface edge must be at or just below the immediately surrounding terrain.
  (04)   Streams should break at road crossings (culvert locations). These road fills should not be removed from DEM. However, streams and rivers should **not** break at bridges. Bridges (as defined in the USGS Lidar Base Specification v1.3) shall be removed from the DEM. When the identification of a feature as a bridge or culvert cannot be made reliably, the feature should be regarded as a culvert.
  (05)   The first two paragraphs of the Digital Elevation Model Hydro-Flattening section of USGS Lidar Base Specification v1.3 apply to non-hydrographic terrain generation below bridges. The bare earth surface below the bridge shall be a continuous logical interpolation of the apparent terrain lateral to the bridge deck. Where

abutments are clearly visible, the bare earth interpolation shall begin at the junction of the bridge deck and approach structure. Where this junction is not clear the contractor shall use their best judgment to delineate the separation of below-bridge terrain from elevated bridge surface.

(06) No geometric changes shall be made to the originally computed lidar points. Bare-earth lidar points that are near the breaklines shall be classified as Ignored Ground (class value equal to 10) and excluded from the DEM generation process. This process prevents unnatural surface artifacts from being created between mass points and breakline vertices. The proximity threshold for reclassification as Ignored Ground is at the discretion of the data producer, but in general shall not exceed the aggregate nominal pulse spacing (ANPS).

(07) Streams, rivers, and water bodies meeting the criteria for hydro-flattening in the USGS Lidar Base Specification v1.3 shall be monotonically continuous where bridge decks have been removed.

(08) All breaklines used to enforce a logical terrain surface below a bridge shall be considered a required deliverable.

C.1.c.(ii)(c) **Non-Tidal Boundary Waters**:

(01) Represented only as an edge or edges within the project area; collection does not include the opposing shore.

(02) The entire water surface edge must be at or below the immediately surrounding terrain.

(03) The elevation along the edge or edges should behave consistently throughout the project. May be a single elevation (i.e., lake) or gradient (i.e., river), as appropriate.

C.1.c.(ii)(d) **Tidal Waters**:

(01) Water bodies such as oceans, seas, gulfs, bays, inlets, salt marshes, very large lakes, etc. Includes any significant water body that is affected by tidal variations.

(02) Tidal variations over the course of a collection, and between different collections, will result in discontinuities along shorelines. This is considered normal and these "anomalies" should be retained. The final DEM should represent as much ground as the collected data permits.

(03) Variations in water surface elevation resulting in tidal variations during a collection should NOT be removed or adjusted, as this requires either the removal of ground points or the introduction of unmeasured ground into the DEM. The USGS NGP priority is on the ground surface, and accepts the unavoidable irregularities in water surface.

(04)   Scientific research projects in coastal areas often have very specific requirements with regard to how tidal land-water boundaries are to be handled. For such projects, the requirements of the research will take precedence.

C.1.d.   **DELIVERABLE PRODUCTS:** The following deliverable products shall be produced from the lidar produced in C.1.c above.

C.1.d.(i)   **Classified Point Cloud**:

C.1.d.(i)(a)   Fully compliant LAS v1.4, Point Record Format 6, 7, 8, 9, or 10 including "File Source ID" which shall be set to 0.

C.1.d.(i)(b)   **Proper use of the LAS withheld and overlap bits is required**. Outlier, blunders, geometrically unreliable points near the extreme edge of the swath, and any other points the data producer deems unusable are to be identified using the withheld bit flag, as defined in LAS specification version 1.4-R13 (ASPRS, 2011).Use of the overlap bit flag is intended to identify overage points, which are described as those points within a given swath that would be excluded when constructing a coverage with a uniform depth of swaths at any location within the project.

C.1.d.(i)(c)   LAS v1.4 deliverables with waveform data are to use external "auxiliary" files with the extension ".wdp" for the storage of waveform packet data. See the LAS v1.4 Specification for additional information.

C.1.d.(i)(d)   Georeference information included in LAS header (OGC WKT). In accordance with LAS specification Version 1.4 - R13 published 15 July 2013, the Coordinate Reference System (CRS) shall be represented in each LAS file using OGC (2001) dialect of Well Known Text (WKT) (www.opengeospatial.org/standards/ct, document # 01-009). ESRI WKT or OGC (2015) dialects are not accepted. Refer to USGS Lidar Base Specification v1.3 Coordinate Reference System, Well-Known Text for more detail.

C.1.d.(i)(e)   GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each return. In compliance with LAS specification requirements, the encoding tag in the LAS header must be properly set.

C.1.d.(i)(f)   Intensity values, normalized to 16 bit, linear rescaling.
See LAS specification version 1.4-R13 (ASPRS, 2011).

C.1.d.(i)(g)   Tiled delivery, without overlap

C.1.d.(i)(h)   Classification Scheme (minimum):

          (01)   Class 1 – Processed, but unclassified
          (02)   Class 2 – Bare-earth ground
          (03)   Class 7 – Low Noise (low, manually identified, if necessary)
          (04)   Class 9 — Water
          (05)   Class 17 — Bridge Decks
          (06)   Class 18 – High Noise (high, manually identified, if necessary)
          (07)   Class 20 — Ignored Ground (breakline proximity)
          (08)   Class 21 – Snow (if present and identifiable)
          (09)   Class 22 – Temporal exclusion (typically non-favored data in intertidal zones)

C.1.d.(i)(i)   *Note: Classes 7 and 18 are included as a convenience for the data producer. It is not required that all "noise" be assigned to those Classes.*

C.1.d.(ii)   **Bare Earth Surface (Raster DEM):**
C.1.d.(ii)(a)   **QL1** portion of AOI: Cell Size no greater than 0.5 meters, and no less than the design Aggregate Nominal Pulse Spacing (ANPS). **QL2** portion of AOI: Cell Size no greater than 1.0 meter, and no less than the design Aggregate Nominal Pulse Spacing (ANPS).

C.1.d.(ii)(b)   Delivery in an industry-standard, GIS-compatible, 32-bit floating point raster format (ERDAS Imagine ".img" preferred).

C.1.d.(ii)(c)   Georeference information as appropriate for the file format to include both horizontal and vertical systems. The vertical system name shall include the geoid model used to convert from ellipsoid heights to orthometric heights.

C.1.d.(ii)(d)   Tiled delivery, without overlap or gaps.

C.1.d.(ii)(e)   Tiles shall be suitable for creating seamless data mosaics

C.1.d.(ii)(f)   DEM tiles will show no edge artifacts or mismatch. A quilted appearance in the overall project DEM surface, whether caused by differences in processing quality or character between tiles, swaths, lifts, or other non-natural divisions, will be cause for rejection of the entire DEM deliverable.

C.1.d.(ii)(g)   Void areas (i.e., areas outside the project boundary but within the tiling scheme) shall be coded using a unique "NODATA" value.

This value shall be identified in the appropriate location within the file header.

C.1.d.(ii)(h)   A report on the assessed absolute vertical accuracy (NVA and VVA) of the bare-earth surface in accordance with the guidelines set forth in the "Positional Accuracy Standards for Digital Geospatial Data" (ASPRS, 2014). Absolute vertical accuracy requirements using the ASPRS methodology for the bare-earth DEM are listed in "Absolute vertical accuracy for digital elevation models, Quality Level 0–Quality Level 3" (table 5).

C.1.d.(ii)(i)   Depressions (sinks), natural or man-made, are not to be filled (as in hydro-conditioning or hydro-enforcement).

C.1.d.(ii)(j)   Water Bodies (ponds and lakes), wide streams and rivers ("double-line"), and other non-tidal water bodies as defined in Section III are to be hydro-flattened within the DEM. Hydro-flattening shall be applied to all water impoundments, natural or man-made, that are larger than ~2 acre in area (equivalent to a round pond ~350' in diameter), to all streams that are nominally wider than 100', and to all non-tidal boundary waters bordering the project area regardless of size. The methodology used for hydro-flattening is at the discretion of the data producer.

C.1.d.(ii)(k)   Bridges (as defined in the USGS Lidar Base Specification v1.3) shall be removed from the DEM. Roads or other travel ways over culverts shall remain intact in the surface.

C.1.d.(ii)(l)   The bare earth surface below a bridge shall be a continuous logical interpolation of the apparent non-hydrographic terrain lateral to the bridge deck. Where abutments are clearly visible, the bare earth interpolation shall begin at the junction of the bridge deck and approach structure. Where this junction is not clear, the contractor shall use their best judgment to delineate the separation of below-bridge terrain from elevated bridge surface. (See USGS Lidar Base Specification v1.3, section on Digital Elevation Model Hydro-Flattening.)

C.1.d.(ii)(m)   No geometric change shall be made to the originally computed lidar points. Bare-earth lidar points that are near breaklines shall be classified as Ignored Ground (class value equal to 10) and shall be excluded from the DEM generation process. This process prevents unnatural surface artifacts from being created between mass points and breakline vertices. The proximity threshold for reclassification as Ignored Ground is at the discretion of the data producer, but in

general shall not exceed the aggregate nominal pulse spacing (ANPS).

C.1.d.(ii)(n)   Streams, rivers, and water bodies meeting the criteria for hydro-flattening in the USGS Lidar Base Specification v1.3 shall be monotonically continuous where bridge decks have been removed.

C.1.d.(ii)(o)   Any breaklines used to enforce a logical terrain surface below a bridge shall be considered a required deliverable.

C.1.d.(iii)   **Breaklines:**

C.1.d.(iii)(a)   ~~Breakline data shall conform to the requirements defined in **"EleHydro Breakline GIS Data Dictionary"** section of Version 1.3.~~

C.1.d.(iii)(b)   Breaklines for all hydro-flattened areas will be delivered, regardless of technique used for hydro-flattening the DEM.

C.1.d.(iii)(c)   Breaklines delivered in ESRI file geodatabase formats, as PolylineZ and PolygonZ feature classes, as appropriate to the type of feature represented and the methodology used by the data producer.

C.1.d.(iii)(d)   Breaklines shall be developed to the limit of the Buffered Project Area (BPA).

C.1.d.(iii)(e)   Breaklines in the same coordinate reference system and units (horizontal and vertical) as the lidar point delivery.

C.1.d.(iii)(f)   Breakline delivery may be in a single layer or in tiles, at the discretion of the data producer. In the case of tiled deliveries, all features shall edge-match exactly across tile boundaries in both the horizontal (x, y) and vertical (z) spatial dimensions. Delivered data shall be sufficient for the USGS to effectively re-create the delivered DEMs using the lidar points and breaklines without substantial editing.

C.1.d.(iv)   **Intensity Image:** An intensity Image shall be produced for each tile.

C.1.d.(iv)(a)   Cell size shall be **0.5 meters** for the **QL1** portion of AOI and cell size shall be **1.0 meter** for the **QL2** portion of the AOI.

C.1.d.(iv)(b)   Image shall be 8-bit, 256 color gray scale and GeoTIFF format

C.1.d.(iv)(c)   Images shall be tiled to match the Classified LAS and DEM files

C.1.d.(v)   **Control:** Control, as defined in C.1.b.(viii) above shall be delivered to the Government as specified in C.2. Digital Deliverables.

C.1.d.(vi)   **Delivery Diagram:** A final project-wide Delivery Diagram is required for QL2 projects over 3,000 square miles and QL1 projects over 1,000 square miles.

C.1.d.(vi)(a)   A Delivery Diagram, which defines the Delivery Block(s), shall be provided in ESRI shapefile or geodatabase format.

C.1.d.(vi)(b)   As reasonable and practical, project area shall be divided into 3,000 square mile blocks for QL2 data and approximately 1,000 square mile blocks for QL1 data.

C.1.d.(vi)(c)   Remaining area, which falls below the 3,000/1,000 square mile threshold, shall be evenly distributed among the designated Delivery Blocks or shall be delivered as a separate block.

C.1.d.(vi)(d)   A Delivery Diagram, as defined in "Attachment C", shall accompany each delivery.

C.1.d.(vii)   **Metadata:** The following requirements for Metadata shall be met:

C.1.d.(vii)(a)   Ancillary products used to support processing of the lidar dataset shall be delivered.

C.1.d.(vii)(b)   Collection Report detailing mission planning and flight logs. Additionally, **a flight index shall be delivered in file geodatabase format.** Flight index shall contain flight line ID, acquisition date, start time and end time for each flight line.

C.1.d.(vii)(c)   Georeferenced, polygonal extents detailing actual coverage of each of the lidar swaths shall be delivered as defined in the referenced Version 1.3 specification. Esri geodatabase is required.

C.1.d.(vii)(d)   Survey Report detailing the collection of control and check points used for calibration and quality assurance/quality control (QA/QC).

C.1.d.(vii)(e)   Processing Report detailing calibration, classification, and product generation procedures including methodology used for breakline collection and hydro-flattening.

C.1.d.(vii)(f)   QA/QC Reports (detailing the analysis, accuracy assessment and validation of:

(01)	The point data (absolute, within swath, and between swath)
(02)	The bare-earth surface (absolute)
(03)	Other optional deliverables as appropriate

C.1.d.(vii)(g)   Control points and check points: All control and check points used to calibrate, control, process, and validate the lidar point data or any derivative products are to be delivered. **All check points shall be delivered with each delivery block.**

C.1.d.(vii)(h)   Geo-referenced, digital spatial representation (shapefile) of the precise extents of each delivered dataset. This should reflect the extents of the actual lidar source or derived product data, exclusive of Triangular Irregular Network (TIN) artifacts or raster NODATA areas. A union of tile boundaries or minimum bounding rectangle is not acceptable. ESRI Polygon shapefile is preferred.

C.1.d.(vii)(i)   Product metadata (FGDC compliant, XML format metadata). One file for each:

    (01)   Tiled deliverable product group (classified point data, bare-earth DEMs, etc.) Product group metadata should contain contents unique and specific to that product group, a renamed copy of the project level metadata is not sufficient. Metadata files for individual tiles are not required.

C.1.d.(vii)(j)   *Note that the NGP version 1.3 of the Lidar Base Specification has a modified XML metadata template to reflect other updates in the specification, careful review is advised.*

C.1.d.(viii)   **Project Report:** The contractor shall deliver a production report which details:

C.1.d.(viii)(a)   A record of field work procedures.

C.1.d.(viii)(b)   Data derivation and adjustments.

C.1.d.(viii)(c)   Quality control procedures and results.

C.1.d.(viii)(d)   Any problems encountered and solutions used in resolving such problems.

C.1.d.(viii)(e)   Statistical report summarizing the results of the airborne GPS adjustment and the overall accuracy of the adjusted IMU data.

C.1.d.(viii)(f)   Production report shall be Microsoft Word, Adobe PDF format or other compatible digital format.

C.1.d.(ix)   **Acquisition Reports:** Contractor shall provide regular progress updates to the technical point of contact throughout the data acquisition process.

C.1.d.(ix)(a)   Update frequency shall be based upon the collection period, but no less that once a week.

C.1.d.(ix)(b)   Reports shall be delivered as shapefiles which represent the geographic extent of the acquired data.

C.1.d.(ix)(c)   Updates shall commence at acquisition onset and shall continue until acquisition is complete

C.1.d.(x)   **Project Pilot:** Contractor shall deliver a Project Pilot consisting of no less than 4 tiles of the CLASSIFIED LAS, hydro-flattened Bare-Earth DEM tiles and breaklines. Pilot delivery shall report the NVA of the UNCLASSIFIED point cloud and Bare-Earth DEM.

C.1.d.(xi)   **All hydro flattened** materials shall be delivered (chiefly, if other techniques than breaklines were used) and shall be delivered in mutually agreeable format, preferably ESRI Shapefile format.

C.1.e.   **TILING SCHEME AND DATA FORMAT:**

C.1.e.(i)   **Tile Coverage:** Tiles which lie completely within the project area shall be complete to the tile edges. Tiles which lie partially outside the project boundary shall be complete to the project boundary with enough overlap beyond the project boundary to ensure that no parts of the project are omitted.

C.1.e.(i)(a)   **Tile Size: Albers Deliverable**
(01)   Tiles shall be 1000 meters x 1000 meters.

(02)   Tiled deliverables shall conform to the tiling scheme, without added overlap.

(03)   Tiling scheme will be used for all tiled deliverables.

(04)   Tiled deliverables shall edge-match seamlessly in both the horizontal and vertical.

C.1.e.(i)(b)   **Tile Size: State Deliverable**
(01)   Tiles shall be 2000 meters x 2000 meters for raster deliverables. Tiles for the classified las shall be 1000 meters x 1000 meters.

(02)	Tiled deliverables shall conform to the tiling scheme, without added overlap.
(03)	Tiling scheme will be used for all tiled deliverables.
(04)	Tiled deliverables shall edge-match seamlessly in both the horizontal and vertical.

C.1.e.(i)(c)   **Tile Naming: Albers Deliverable**

The standard naming convention is based on the easting and northing locations of the lower left corner for each tile, for ease of searching. An example of a tile name for a 1-km tile is w0002n0612.

C.1.e.(i)(d)   **Tile Naming: State Deliverable**

Tiles shall be named according to the U.S. National Grid System based on the SW corner (ex. 12TVK060160).

C.1.e.(i)(e)   **Spatial Reference System**: **Albers Deliverable**

(01)	Spatial Reference System for delivery of the AOIs shall be: data referenced to NAD83 (2011), **Albers Equal Area**, Meters; NAVD88 (using the latest Geoid model available from the National Geodetic Survey), Meters.
(02)	All data shall be delivered in Orthometric Heights.
(03)	****NOTE****_In all cases, the CRS that is used shall be recognized and published by the European Petroleum Survey Group (EPSG) and correctly recognized by industry standard geographic information system (GIS) software applications. For Albers Equal Area, (European Petroleum Survey Group [EPSG] code is 6350). **EPSG shall be cited in the technical proposal.**_

C.1.e.(i)(f)   **Spatial Reference System**: **State Deliverable**

(01)	Spatial Reference System for delivery of the AOIs shall be: data referenced to NAD83 (2011), Universal Transverse Mercator (UTM) Zone 12 (WKID 6341); NAVD88 (using the latest Geoid model available from the National Geodetic Survey), Meters. Horizontal and vertical units shall be meters.
(02)	All data shall be delivered in Orthometric Heights.
(01)	****NOTE****_In all cases, the CRS that is used shall be recognized and published by the European Petroleum_

Survey Group (EPSG) and correctly recognized by industry standard geographic information system (GIS) software applications. For Albers Equal Area, (European Petroleum Survey Group [EPSG] code is 6350). **EPSG shall be cited in the technical proposal**

C.1.f.   **NOTIFICATION:** The Government POC named below shall be notified within 24 hours of the start of acquisition of data. Notification can be made by e-mail and is for information purposes only, not permission to proceed.

C.1.g.   **PERMITS:** The contractor shall be responsible for obtaining all permits which may be required in the performance of this task order, which shall include, but not be limited to any permits for acquisition of data in controlled or restricted airspace, and access to control points on the ground.

C.1.h.   **USE AND DISTRIBUTION RIGHTS:** All deliverable data and documentation shall be free from restrictions regarding use and distribution. Data and documentation provided under this Task Order shall be freely distributable by government agencies.

C.1.i.   **CERTIFICATIONS:** The contractor shall certify as part of its proposal that the work performed on this task order complies with Section 52.225-05 of the Federal Acquisition Regulations relating to Trade Agreements.

C.1.j.   **THE GOVERNMENT POINT-OF-CONTACT (POC)** FOR THIS TASK ORDER: The Government Point of Contact for this task order and any modifications shall be the POC listed below.

Address: USGS/NGTOC   **Telephone: 573-308-3538**

ATTN: Leslie Lansbery, MS 668   **e-mail:** llansbery@usgs.gov
          1400 Independence Road
          Rolla, MO 65401

C.2.   **Digital Deliverables**: Reference C.1 - 3.11 of the Contract.

C.2.a.   **The Contractor shall deliver four (4) copies** of the final Lidar data products and documentation as specified in Section C.1 of this Task Order to:
          Leslie Lansbery, MS 668
          1400 Independence Road
          Rolla, MO 65401
          llansbery@usgs.gov

C.2.b.   **Format:** Data shall be delivered in the formats specified in C.1.d above.

C.2.c.   **Delivery Medium:** The digital data shall be delivered on external hard drive, i.e. (eSATA or USB2/3 – Less than USB2 is not acceptable). Files shall be stored into appropriate directories on the drive. **Refer to "Attachment D."**

C.2.d.   **Deliverable Validation:** Reference C.1 - 3.12 of the Contract. The Government may choose to contract with a separate contractor for validation on all submitted deliverables.

SECTION D: - PACKAGING AND MARKING

D.1.   No additional Section D requirements are applicable to this Task Order.

SECTION E: - INSPECTION AND ACCEPTANCE - The following Section E additional requirements are applicable to this Task Order:

E.1.   **Inspection Period:** Reference GS0720 of the Contract. The inspection period begins the day after the data has been delivered. All deliverables will be validated within a Sixty (60) calendar-day inspection period, with the exception of the Pilot Data which will be reviewed within seven (7) calendar days.

E.2.   **Inspection and Acceptance Procedures:** Reference E780 of the Contract. The Government will perform a full inspection of all deliverables in accordance with E780 (b) of the Contract.

E.3.   **Nonconforming deliverables:** Nonconforming deliverables returned to contractor for rework shall be delivered in accordance with Contract clause E784.

SECTION F: - DELIVERIES OR PERFORMANCE - The following Section F additional requirements are applicable to this Task Order:

F.1.   **Place of Delivery:** Reference GS0904 of the Contract. Contractor shall submit all requested deliverables to the address of the POC, as shown in Section C of this Task Order.

F.2.   **Negotiated Delivery Schedule:** Reference F981 of the Contract. The Government requires the following delivery schedule:

F.2.a.   **Lot One (1) Kick-off Meeting:** A kick-off meeting will be held to outline communication procedures that will be followed for lidar data acquisition with respect to verification of local ground conditions and vegetation

requirements. The kick-off meeting shall be held no later than two (2) weeks after task order award and prior to data acquisition.

F.2.b.   **Lot Two (2) Lidar Data Acquisition Updates:** During this time the contractor will submit regular lidar data acquisition updates in the form of shapefile(s) which represent the acquired geographic extent. Regular lidar data acquisition updates shall commence upon the start of the lidar data acquisition and shall conclude upon lidar data acquisition completion on or around **August 30, 2018.**

F.2.c.   **Lot Three (3): Lidar Data Acquisition:** The lidar data acquisition shall be completed by **August 30, 2018,** weather and ground conditions permitting.

F.2.d.   **Lot Four (4): Ground Control Surveys** shall be completed by **August 30, 2018** weather and ground conditions permitting.

F.2.e.   **Lot Five (5): Project Pilot Delivery** consisting of the NVA reporting of the point cloud data, consisting of no less than 4 tiles of classified LAS data in each of the primary land cover categories (NVA/VVA categories) and corresponding hydro flattened bare earth DEMs. This pilot data shall be delivered no later than **60 calendar days** following completion of data acquisition, control surveys and lidar flight line calibration (whichever occurs later), but in no case later than **September 30, 2018.**

F.2.f.   **Lot Six (6) Delivery of one Block:** One (1) Delivery Block consisting of all required deliverables (including Metadata) of the lidar data and its derived products, as specified in the task order, shall be organized and delivered according to Section C.1.d. (vi) and shall be delivered following Government response to Pilot Data, but no later than **November 1, 2018.**

F.2.g.   **Lot Seven (7) Delivery of one Block:** One (1) Delivery Block consisting of all required deliverables (including Metadata) of the lidar data and its derived products, as specified in the task order, shall be organized and delivered according to Section C.1.d. (vi) and shall be delivered following Government response to Pilot Data, but no later than **December 31, 2018.**

F.2.h.   **Lot Eight (8):** Four (4) copies of the final accepted lidar data products and documentation shall be delivered per Section C.2.a of the task order, not later than 30 days following acceptance of Lot 7, but no later than **March 15, 2019.**

F.3.   **Progress Reports:** Contractor shall submit a monthly progress report for this task order in accordance with Contract clause GS0921 and GS0931.

SECTION G: - CONTRACT ADMINISTRATION DATA

G.1. No additional Section G requirements are applicable to this Task Order

SECTION H: - SPECIAL CONTRACT REQUIREMENTS -The following Section H additional requirements are applicable to this Task Order:

H.1. **Regulations And Permits -- Aircraft Operations**: Reference H1344 of the contract. The contractor shall be responsible for applying for and obtaining any required permits for access, over-flight, or intrusion to restrict or otherwise limited ground access and/or airspace, which may be included within the requirement of this task order.

H.2. **Government Furnished Property:** Reference H1480 (Conditions Regarding Use of GFP) of the contract. No Government furnished property is being supplied with this Task Order.

SECTION I: - CONTRACT CLAUSES

I.1. No additional detail is required for this Task Order.

SECTION J: - LIST OF DOCUMENTS, EXHIBITS AND OTHER ATTACHMENTS

J.1.	Attachment A -	Project Area Description	1 Page
J.2.	Attachment B -	Shapefiles	1 Page
J.3.	Attachment C -	Final Delivery Diagram	1 Page
J.4.	Attachment D -	Folder Structure	1 Page

TASK ORDER Attachment A -
UT_FEMAHQ_2018_D18 – Project Description and Diagram
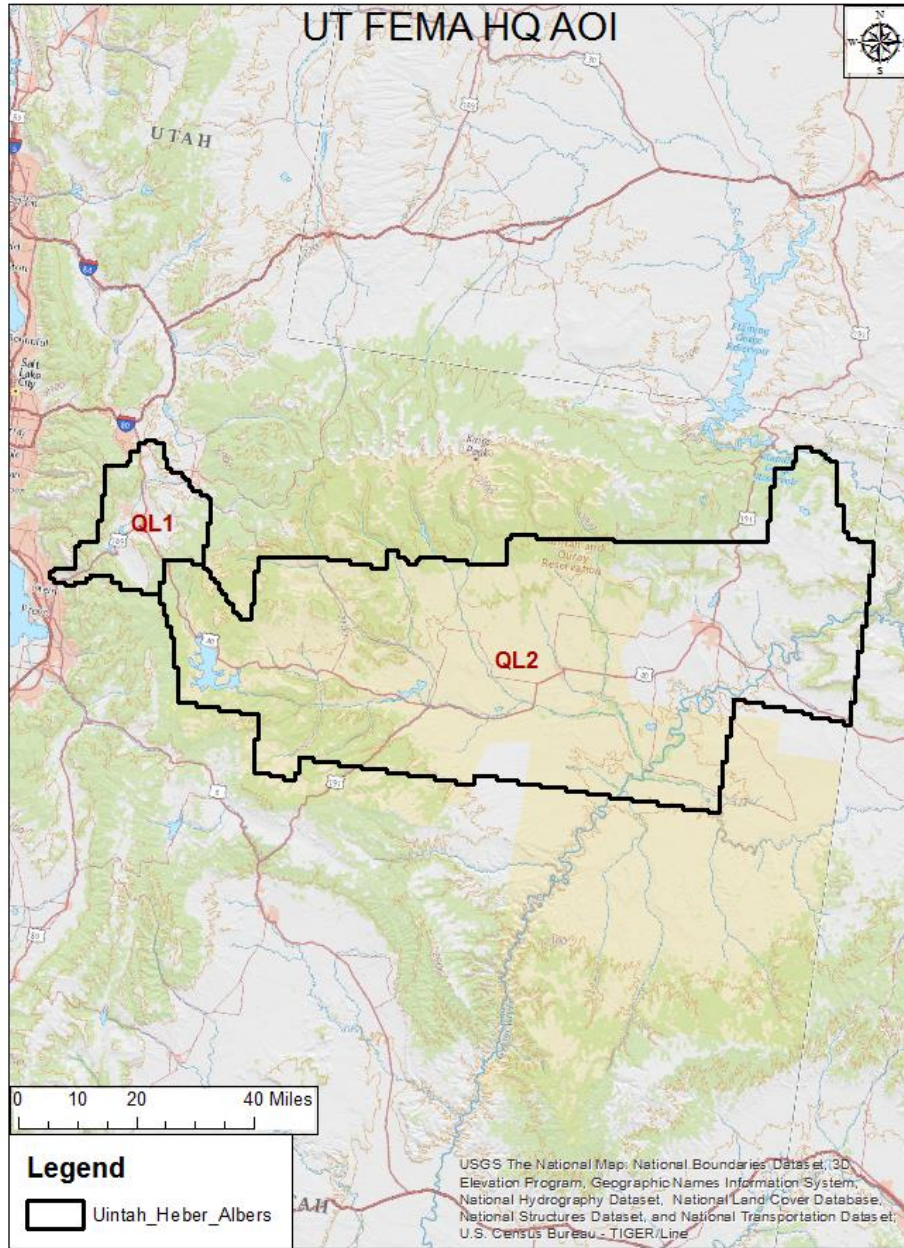
END "ATTACHMENT A"
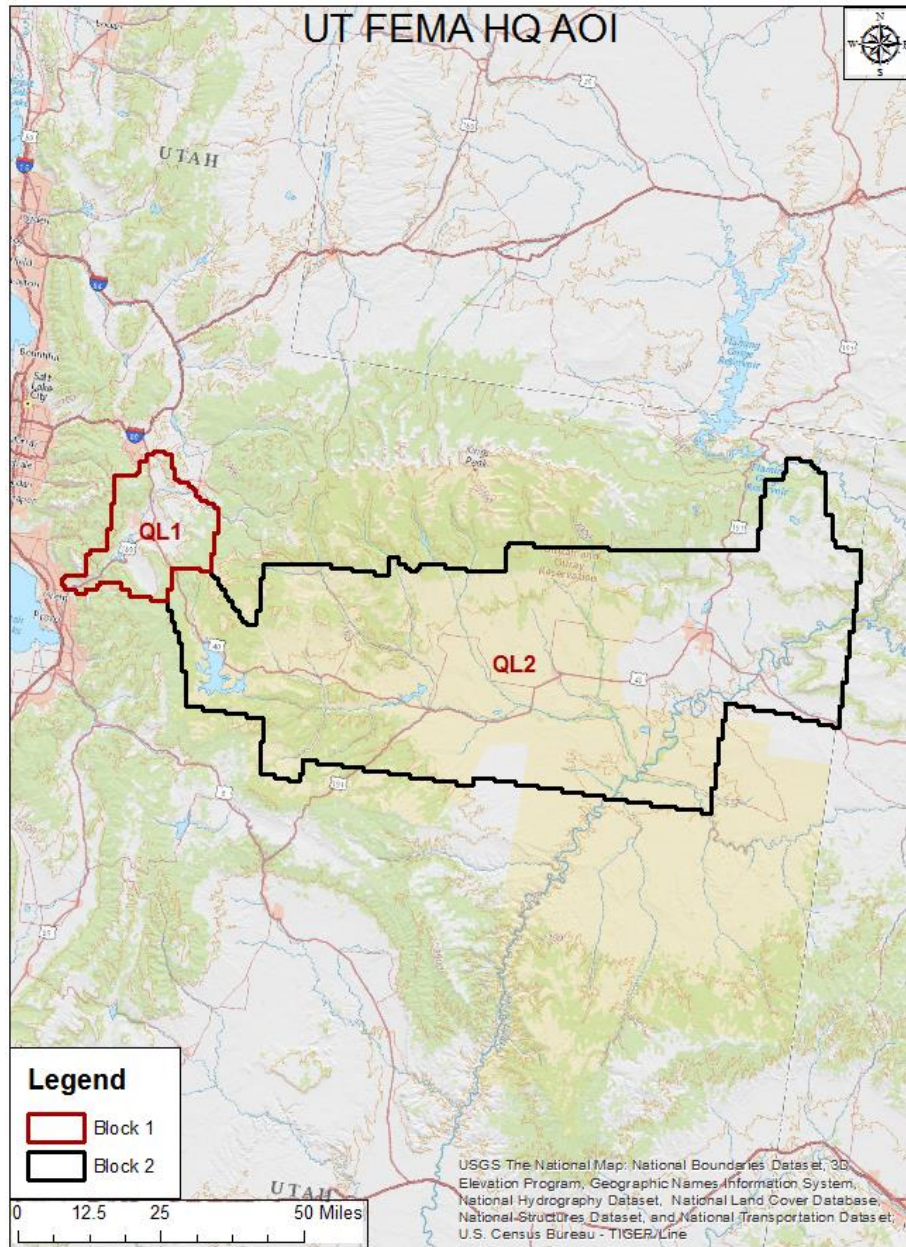
TASK ORDER Attachment B -

THIS SECTION CONSISTS OF THE FOLLOWING DATA SET(S)

UT_FEMAHQ.zip

Folder_Structure.zip

END "ATTACHMENT B"

TASK ORDER Attachment C – Final Delivery Diagram

END "ATTACHMENT C"

TASK ORDER Attachment D – Folder Structure

Task Name
    Delivery Lot Number
        -- *[Delivery Block 1]*
           -- metadata
           -- bare_earth
           -- other
           -- point_cloud
        -- *[Delivery Block 2]*
           -- metadata
           -- bare_earth
           -- other
           -- point_cloud

Folder	Subfolder	Contents
metadata		
	reports	Reports provided by the data producer, the task order for the project and XML metadata
	shapefiles	Supplemental shapefiles or feature classes
bare_earth		
	be_rasters	All final bare earth raster tiles
	breaklines	Breaklines used to create the bare earth rasters if used by the data producer
other		
	other files	Any other information that does not fit into another folder or subfolder.
point_cloud		
	~~swathcls~~	~~Point cloud LAS files that have been classified and have the extent of the original flight lines~~
	~~swathuncls~~	~~Point cloud LAS files that are unclassified and have the extent of the original flight lines~~
	tilecls	Point cloud LAS files that have been classified and are tiled similarly to other deliverables
	tileuncls	Point cloud LAS files that are unclassified and are tiled similarly to other deliverables

END "ATTACHMENT D"