

II. FISCAL IMPACT ANALYSIS

A. Five Year Summary of Fiscal Impact:

Fiscal Years	2025	2026	2027	2028	2029
Capital Expenditures	<u>\$451,978</u>	_____	_____	_____	_____
Operating Costs	_____	_____	_____	_____	_____
External Revenues	_____	_____	_____	_____	_____
Program Income (County)	_____	_____	_____	_____	_____
In-Kind Match (County)	_____	_____	_____	_____	_____
NET FISCAL IMPACT	<u>\$451,978</u>	_____	_____	_____	_____
# ADDITIONAL FTE POSITIONS (Cumulative)	_____	_____	_____	_____	_____

Is Item Included in Current Budget? Yes X No _____

Does this item include the use of federal funds? Yes _____ No X

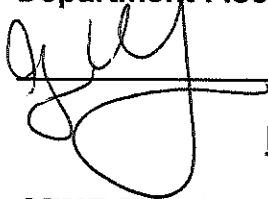
Does this item include the use of state funds? Yes _____ No X

Budget Account No.:

Fund 3901 Department 491 Unit 1451 Object 3401 RVSC _____

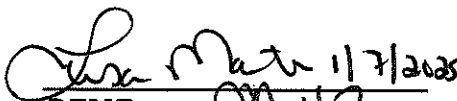
B. Recommended Sources of Funds/Summary of Fiscal Impact:
 Palm Beach County's Informational Systems Services has already budgeted for the full cost of LiDAR acquisition and processing.


C. Department Fiscal Review:



III. REVIEW COMMENTS

A. OFMB Fiscal and /or Contract Dev. and Control Comments:


 OFMB JA 1/7
 MD 1/7


 Contract Development & Control 1/7/24

B. Legal Sufficiency:


 Assistant County Attorney

C. Other Department Review:

 Department Director

2025 QL1 Palm Beach County LiDAR

**RESEARCH AGREEMENT
BY AND BETWEEN****PALM BEACH COUNTY BOARD OF COUNTY COMMISSIONERS****AND****THE UNIVERSITY OF SOUTH FLORIDA BOARD OF TRUSTEES**

THIS RESEARCH AGREEMENT IS MADE AND ENTERED INTO BY AND BETWEEN Palm Beach County Board of County Commissioners, a political subdivision of the state of Florida, by and through its Board of County Commissioners, and having a place of business located at 301 N Olive Ave First Floor, West Palm Beach, FL 33401 ("**Sponsor**"), and The University of South Florida Board of Trustees, a public body corporate for the University of South Florida ("**University**"), for support to the project entitled "2025 QL1 Palm Beach County LiDAR". For consideration of the mutual promises, covenants, and obligations contained herein, the **Sponsor** hereby retains the **University** to undertake certain activities described in Attachment 1. The parties agree as follows:

I. PERIOD OF PERFORMANCE

The period of performance under this Agreement begins upon execution of the document by both the Sponsor and University and ends **June 30, 2026**. The contract term may be extended by mutual written agreement of the parties.

II. WORK PLAN / PROJECT ADMINISTRATION

The **University** shall perform the activities described in Attachment 1 and will comply with all statutory requirements and applicable regulations. The project will be conducted under the direction of the **University** "Project Director" (see below). The representatives of the parties are:

University Representatives:

The **University** Project Director:

Thomas Frazer, PhD
University of South Florida
College of Marine Sciences
830 1st Street South
St. Petersburg, FL 33701
727-553-3369

2025 QL1 Palm Beach County LiDAR
Email address: tfrazier@usf.edu

The **University** Administrative Contact:

Ronald Serpenti
Senior Sponsored Research Administrator
University of South Florida
3702 Spectrum Blvd, Suite 165
Tampa, FL 33612-9445
(813) 974-8453
Email: rsch-awards@usf.edu and rserpenti@usf.edu

Sponsor Representatives:

Project Director:

Regina Hagger
Manager, Information Systems Services
Palm Beach County
Governmental Center 7th Floor
301 N Olive Ave
West Palm Beach, FL 33401
561-355-2246

RHagger@pbc.gov

Administrative Contact:

Robyn Lawrence
Division Director V, Financial Management and Budget
Palm Beach County
Governmental Center 8th Floor
301 N Olive Ave
West Palm Beach, FL 33401
561 355-4369

RLawrence@pbc.gov

III. ALLOCATION OF FUNDS

Sponsor agrees to compensate the **University** on a **fixed price** basis, as per Attachment 2, for an amount of **\$451,978.00 USD**. It is further agreed that all invoices should contain an original signature of an authorized official of the **University** and should be sent to **Sponsor's** Project Director for approval (see Article II for the address). Invoices shall be submitted to **Sponsor** according to the schedule in Attachment 2. Payments shall be remitted to:

University of South Florida
Attention: USF Business Payments - PS
P.O. Box 737443
Dallas, TX 75373-7443

IV. PAYMENT RESPONSIBILITIES

Sponsor shall issue payment in U.S. dollars within 45 days after receipt of an invoice and receipt of supporting documentation in accordance with the terms and conditions of this Agreement.

V. INDEPENDENT CONTRACTOR

The relationship of the parties is that of mutually independent contractors. Each party and its officers, employees, agents, subcontractors, or other contractors shall not be deemed by virtue of this Agreement to be the officers, agents, or employees of the other party.

VI. LIABILITY

Sponsor and **University** agree, to the extent of their waiver of sovereign immunity under §768.28, Florida Statutes to be responsible for actual damages that are attributable to the negligent acts or omissions of **Sponsor** or **University** and their respective officers, agents, and employees acting within the scope of their employment by **Sponsor** or **University**. This statement shall not be construed or interpreted as consent by **Sponsor** or **University** to be sued or as a waiver of **Sponsor** or **University's** sovereign immunity under §768.28, Florida Statutes.

VII. TERMINATION

This Agreement may be canceled by either party upon no less than thirty (30) days written notice, with or without cause; notice shall be delivered by certified mail, return receipt requested, or in person with proof of delivery. In case of cancellation, only the percent of satisfactory progress actually achieved as of the date of termination, plus any non-cancellable obligations, will be due and payable to the **University**.

In the event that **University's** project director becomes unable or unwilling to continue the project activities, and a mutually acceptable substitute is not available, **Sponsor** has the option to terminate this Agreement.

VIII. PUBLICITY

Neither party shall use the name of the other party, or its employees in any publicity, advertising, or news release without the prior written approval of an authorized representative of that party. **University** is required by §1004.22, Florida Statutes, to make available, upon request, the title and description of a research project, the name of the researcher (**University** Project Director), and the amount and source of funding provided for the project.

IX. CONFIDENTIALITY

During the term of this Agreement, it may be necessary for either party to disclose to the other information or data that is confidential and proprietary to that party. All such confidential information will be clearly marked or identified as confidential at the time of disclosure or, if given orally, will be reduced to writing within 30 days. Each party agrees to hold confidential information it receives from the other party in confidence for at least five years from the date the confidential information is either returned or destroyed as requested by the disclosing party.

The parties will take reasonable precautions to avoid disclosure, publication or dissemination of such confidential information and to use such confidential information only in connection with the project. No obligation of confidentiality applies to any information which was already in the receiving party's possession prior to its receipt from the disclosing party; is or becomes publicly known or available through no breach of this Agreement by the receiving party; is acquired by the receiving party from a third party without notice or restrictions of confidentiality; is independently developed by the receiving party's personnel to whom the providing party's confidential information had not been disclosed; or is required to be disclosed by law or governmental regulation, in which case both parties will work together in order to comply with such requirement.

X. PUBLICATIONS

Sponsor recognizes that under **University** policy, the results of the project must be publishable and agrees that the **University** Project Director or **University** employees engaged in the project shall be permitted to present at symposia, national, or regional professional meetings, and to publish in journals, theses or dissertations, or otherwise of their own choosing. Prior to any publication or presentation, **Sponsor** reserves the right to review the publication or presentation to restrict any unwanted and/or unintended transmission of protected intellectual property. **Sponsor** reserves the right to use the data collected in marketing materials following consultation of the **University** to ensure accuracy of information

XI. INTELLECTUAL PROPERTY

University agrees that the **University** Project Director will promptly disclose all intellectual property ("IP") generated during the course of this Agreement to **University** Patents & Licensing in accordance with USF System Policy 0-300 on Inventions and Works, and Patents & Licensing will promptly disclose the IP to **Sponsor**.

University owns IP that is conceived or made by **University** Project Director or any other **University** employee. **Sponsor** owns all IP that is conceived or made by employees of **Sponsor**. **University** and **Sponsor** jointly own IP that is conceived or made by employees of **University** or **Sponsor**.

Any background IP and technologies of **Sponsor**, the **University**, the University Project Director or other **University** employee existing prior to the execution of this Agreement are their own separate property, respectively, and are not affected by this Agreement.

XII. GOVERNING LAW

Florida law shall govern the enforcement and interpretation of this Agreement without regard to its conflict of laws provisions.

XIII. INSURANCE

University is a self-insured state university and maintains comprehensive general liability, including medical professional liability, protection coverage of \$200,000 per person, \$300,000 per occurrence, in accordance with §768.28, and either §1004.24, or Chapter 284, Part II, Florida Statutes. **University** maintains workers' compensation insurance in full compliance with Florida law. **University** will provide a certificate of liability protection to **Sponsor** upon request.

Without waiving the right to sovereign immunity as provided by Florida Statute, Chapter 768.28, the **Sponsor** acknowledges to be self-insured for General Liability and Automobile Liability under Florida's sovereign immunity statute with monetary waiver limits of \$200,000 Per Person and \$300,000 Per Occurrence; or such limits that may change and be set forth by the legislature.

The **Sponsor** acknowledges to be self-insured for Worker's Compensation & Employer's Liability insurance in accordance with Florida Statute, Chapter 440.

When requested, the **Sponsor** agrees to provide a Certificate of Insurance evidencing self-insurance and/or sovereign immunity status, which the University agrees to recognize as acceptable for the above mentioned coverages.

XIV. DELEGATION OF AUTHORITY

This Agreement is valid and enforceable only upon being signed by persons authorized to bind the **Sponsor** and **University**, and by all persons required by Florida law or **University** policy to sign an agreement of this nature in order to bind the **University**.

XV. PROTECTION OF HUMAN SUBJECTS AND VERTEBRATE ANIMALS

The **University** bears full responsibility for the proper and safe performance of research involving its use of human subjects under this Agreement. If human subjects are used, their rights and welfare will be protected under 45 CFR Part 46, "Protection of Human Subjects," and the **University** will send a copy of current IRB approval to **Sponsor**.

The **University** bears full responsibility for the proper and safe performance of Research involving the use of vertebrate animals under this Agreement. If any vertebrate animals are used, they will be protected under 9 CFR Chapter 1, Subchapter A, Parts 1, 2, and 3, "Animal Welfare", and the **University** will send a copy of current IACUC approval to the **Sponsor**.

XVI. EXPORT CONTROL

Both parties will comply with all U.S. export control laws and regulations, including but not limited to the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, and all embargoes and/or other restrictions imposed by the Treasury Department's Office of Foreign Asset Controls (OFAC). Should **Sponsor** intend to distribute export controlled technical data or software to **University**, **Sponsor** must provide the **University** Export Control Officer with the appropriate export control designation for such technical data (e.g., ECCN or Munitions List Category) in advance. **University** reserves the right to elect not to receive such export controlled technical data. Approval from **University** Export Control Officer is required prior to acceptance of export controlled technical data. Notification of intended release of technical data from **Sponsor** to **University** can be made via exportcontrol@usf.edu.

SIGNATURE PAGE FOLLOWS

IN WITNESS WHEREOF, the parties have caused this Research Agreement, which includes Attachments 1 and 2 to be executed by their undersigned duly authorized officials.

University of South Florida
Board of Trustees, a public body corporate

Reviewed by:

SIGNED BY:

Thomas Frazer, PhD,
College of Marine Sciences
USF University Project Director

Stephanie Rios,
Director, Sponsored Research
USF Research & Innovation

_____, Inc.

[Signature of Authorized Representative]
Name: _____
Title: _____

Palm Beach County Legal Sufficiency:

Assistant County Attorney

ATTACHMENT 1

SCOPE OF WORK

Thomas Frazer, PhD
College of Marine Sciences
University of South Florida
Principal Investigator

Project Scope and Tasks:

The 2025 QL1 Palm Beach County LiDAR project will acquire QL-1 LiDAR data for all of the land area within Palm Beach County. This includes LiDAR data for the coastal beaches, Lake Okeechobee's Hebert Hoover Dike (HHD), the approximate $\frac{3}{4}$ miles of Belle Glades municipal land located inside Lake Okeechobee. The scope of this work does not include processing of the LiDAR data.

As defined in Attachment 1.1 STATEMENT OF WORK 2025 Palm Beach County, FL LiDAR Acquisition of this attachment the minimum specification for this project is all of the requirements required to produce completely compliant QL-1 LiDAR data.

As defined in Attachment 1.2 Supplemental LiDAR Clarifications and Specifications for QL-1 LiDAR Acquisition Palm Beach County is providing clarifications and specifications to ensure the QL-1 quality data is obtained through the varying land conditions within Palm Beach County.

All work shall a minimum meet the USGS requirements for QL-1 LiDAR. Should a conflict occur between these two sections the more stringent requirement shall control.

2025 QL1 Palm Beach County LiDAR

**ATTACHMENT 1.1
USGS STATEMENT OF WORK**

2025 Palm Beach County, FL LiDAR Acquisition

00202598.DOCX

**ATTACHMENT 1.2
Palm Beach County
Board of County Commissioners**

ISS/GIS

Supplemental LiDAR Clarifications and Specifications for QL-1 LiDAR Acquisition

ATTACHMENT 2

METHOD OF PAYMENT

Sponsor agrees to compensate the **University** on a fixed price basis for an amount of **\$451,978.00 USD**. **University** shall submit invoices according to the following schedule. Payment shall be made within 45 days of approved invoice. Palm Beach County will receive confirmation of acceptance from the USGS or shall be provided sufficient access to review the LiDAR data to ensure compliance with the QL-1 requirements.

Payment Schedule: \$451,978.00 after full acquisition of LiDAR data.

In the event that unobligated funds remain at the conclusion of the project, unobligated funds shall remain with the **University**.

Checks shall be made payable to the University of South Florida and sent to the address listed in Article 3 of this Agreement.

December 23, 2024

USGS STATEMENT OF WORK**2025 Palm Beach County, FL LiDAR Acquisition****1. Purpose**

The U.S. Geological Survey (USGS) and the partner will collaborate to acquire high-resolution digital elevation data developed from airborne lidar for approximately 2,261 square miles of land in the area of interest of Palm Beach County, Florida (see Section 5). This estimate is based on ½ by ½ mile tiles (9,044 tiles) for the land area outside of Lake Okeechobee and three tiles required within Lake Okeechobee for Belle Glade municipal land. For 5,000 feet by 5,000 tiles the estimated areas of the tiles required is 2,184.5 acres (2,436 tiles). The data will be used to generate Digital Elevation Models (DEMs) for use in emergency planning and evacuation routing, resiliency planning, stormwater modeling, airspace management, and flood protection utilizing lidar technology. Data acquisition is planned for winter/spring 2025 (January through March) as conditions allow. Acquisition may extend into later flying seasons if needed based on discussions between the USGS, contractor, and partner. The project will consist of high-accuracy classified bare-earth lidar data in LAZ format as well as raster DEMs per project requirements.

2. General Terms

USGS will select a qualified contractor to perform the lidar collection and processing via the Geospatial Product and Service Contract (GPSC). GPSC task orders are awarded to qualified contractors through federal government solicitation. Qualified contractors are selected for a base contract award in accordance with Public Law 92-528 (Brooks Act) and FAR 36.6 - Architect-Engineering Services, which establishes a qualifications-based selection process, in which contracts for architectural and engineering services are negotiated based on demonstrated competence and qualification for the type of professional services required.

Contractor selection is based on the following 6 criteria:

- (1) Professional qualifications necessary for satisfactory performance of required services;
- (2) Specialized experience and technical competence in the type of work required;
- (3) Capacity to accomplish the work in the required time;
- (4) Past performance on contracts with government agencies and private industry in terms of cost control, quality of work, and compliance with performance schedules;
- (5) Location in the general geographical area of the project and knowledge of the project locality and;
- (6) Acceptability under other appropriate evaluation criteria.

Level of effort is negotiated on each task order issued under the base contracts. This process is aligned with the Department of Interior consultant Request for Proposal (RFP) and selection process.

The task order issued by USGS to the selected GPSC contractor provides full details regarding project collection requirements, deliverables, schedules, and deadlines. A copy of the task order will be provided to the partner.

USGS will:

- Execute separate funding agreements with partners in support of the total project cost.
- Prepare a task order for agreed upon products and services.
- Serve as government point of contact during the full period of the agreement.
- Require that land surveys conducted in support of this project be performed under the supervision of a qualified professional land surveyor.
- Receive, inspect, and catalog 3DEP standard products and deliverables.
- Validate 3DEP standard products and deliverables that meet *USGS Lidar Base Specifications v2024A* (or subsequent version).
- Return data to contractor as needed for error correction/rework.
- Make preliminary data available for download early in the processing phase of a delivery block once it has been determined the point cloud geometry is unlikely to change with future processing. Preliminary data will NOT be provided to partners for Tribal areas (includes Federal and non-Federal partners, restricted and unrestricted Tribal lands).
- Provide one copy of final data to the partner signing the agreement.

Partner will:

- Provide funding for the project as described in the agreement.
- Pay contract project costs plus applicable GPSC assessment fee which is calculated by USGS as 6% of the contracted project cost, not to exceed the amount specified in the agreement.
- Assist USGS in resolving project issues as needed and appropriate.
- Provide available information, including informal observations from interested parties, on ground conditions to facilitate project flight planning.
- Be responsible for reviewing and publishing any non-standard products and deliverables beyond *USGS Lidar Base Specifications v2024A* (or subsequent version).
- Adhere to restrictions regarding the use and distribution of preliminary data.

3. Specifications and Deliverables

Unless otherwise stated, all specifications and deliverables will meet or exceed Quality Level 1 *USGS Lidar Base Specifications v2024A* (or subsequent version) (<https://www.usgs.gov/3DEP/lidarspec>).

General Requirements

- Data shall be Quality Level 1 (QL 1), meeting the following accuracy requirements:

Quality Level	Vertical Accuracy RMSEz	Aggregate Nominal Pulse Spacing (ANPS)	Aggregate Nominal Pulse Density (ANPD)	DEM Post Spacing
1	10 cm	0.35 m	8 pulses/m ²	1.0 feet

- Horizontal Datum: Horizontal NAD83 (2011).
- Vertical Datum: NAVD88 using the most recent approved Geoid model from the National Geodetic Survey (NGS) for purposes of performing conversions from ellipsoidal heights to orthometric heights. Data to be delivered in orthometric heights.
- Coordinate System and Projection: Florida State Plane East horizontal units in feet and vertical units in feet.
- Tiling Scheme: U.S. National Grid naming convention, 5,000 feet x 5,000 feet, non-overlapping tiles
- DEM: 1.0 feet individually tiled from bare-earth, hydro-flattened, delivered in GeoTIFF format.
- Vegetation: Leaf off is preferred, however, as numerous factors will affect vegetative condition at the time of any collection, USGS only requires that penetration to the ground must be adequate to produce an accurate and reliable bare-earth surface.
- Area of interest, acquisition window and conditions, deliverables, and/or specifications may be modified prior to task award if mutually agreed to by the USGS, contractor, and partner.
- Preliminary data deliverables will include the point cloud processed with automated routines to denoise and classify ground, derived bare earth DEMs, swath separation imagery, and product-level metadata. Quality of the point cloud classification, noise isolation, and derived bare earth DEMs may be degraded due to processing with automated routines only, without manual intervention. The point cloud may not include all classification codes expected in the final data product. Data should be geometrically stable; point coordinates will not change in the X, Y, or Z dimensions. No hydro breaklines or hydro-flattening of the bare earth DEMs will be included. Data will be clearly and prominently marked with “preliminary” as a prefix in all file names, metadata, and associated documents. Metadata and any associated documents will state that data has not been validated by USGS and is being provided without warranty or guarantee by the USGS or contractor. Preliminary data may be delivered incrementally.

The lidar data will be processed to produce a classified point cloud, tile-based bare-earth DEMs, and related products. These elevation products will be placed in the public domain and will be made available for viewing and download through the USGS National Map.

Additional Products, Services, and Deliverables beyond USGS Standards

- None

Additional products and services include added level of effort and cost. These costs will be funded solely by the partner.

USGS does not commit to validating these additional products or services. Validation will be the responsibility of the partner and can be accomplished in two ways:

- Before Project Completion: Data will be provided to the partner for validation based on a timeframe negotiated by the USGS, contractor, and partner.
- At Project Completion: Data will be provided to the partner for validation when the project is complete.

In either case, the partner will have 60 days to review data and identify corrections. USGS will pursue corrections on behalf of the partner.

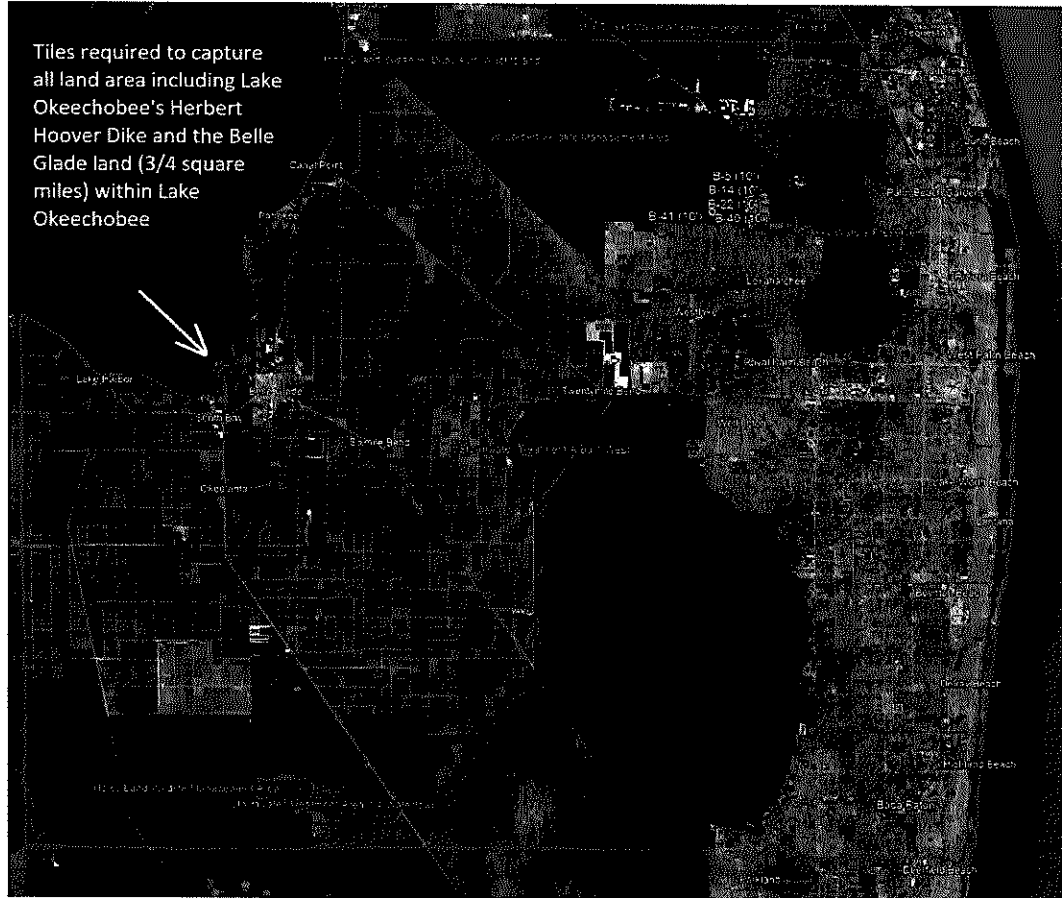
USGS reserves the right but does not commit to publishing these additional products and services.

4. Contacts

USGS Administrative		Partner Administrative
Jim Almekinder	Name	Thomas Frazer, PhD
GPSC Agreement Lead		University of South Florida College of Marine Science
P.O. Box 25046, MS 510	Address	830 1 st Street South
Denver, CO 80225-0046		Saint Petersburg, FL 33701
573-308-3549	Telephone	727-553-3369
jalmekinder@usgs.gov	E-Mail	Tfrazer@usf.edu
USGS Financial		Partner Financial
Janet Anselm	Name	Ronald Serpenti
Program Analyst		Senior Sponsored Research Administrator University of South Florida
1400 Independence Road, MS 323	Address	3702 Spectrum Blvd, Suite 165
Rolla, MO 65401		Tampa, FL 33612-9445
573-308-3814	Telephone	813-974-8453
janselm@usgs.gov	E-Mail	rserpenti@usf.edu
USGS Project Manager		Partner Technical
Michael Bradford	Name	
Project Manager		
1400 Independence Road	Address	
Rolla, MO 65401		
(573) 308-3629	Telephone	
mbradford@usgs.gov	E-Mail	
USGS Liaison		Partner Data Delivery
Kara Doran	Name	
National Map Liaison		
600 4 th Street South	Address	

St. Petersburg, FL 33701		
(727)-278-6385	Telephone	
kdoran@usgs.gov	E-Mail	

5. Project Area Map



Map Showing Land Area for LIDAR Acquisition.



Map of Land Area for LIDAR Acquisition within Lake Okeechobee.

The only two land areas within Lake Okeechobee that PBC would need LIDAR acquisition. For the Lake Harbor this land area is inside of three existing tiles required to capture the Herbert Hoover Dike (HHD). For Belle Glade there are three tiles (beyond what is required to capture the HHD) needed for this interior land.



Palm Beach County

Board of County Commissioners

ISS/GIS

**Supplemental LiDAR Clarifications and Specifications
for QL-1 LiDAR Acquisition**

December 23, 2024

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History

Palm Beach County (PBC) obtained the USGS 3-DEP grant with partners, South Florida Water Management District (SFWMD) and Lake Worth Drainage District, and collected LiDAR during 2016-17. The LiDAR data was collected at QL-2 (1.7 ANPD per meter). Derivative products include Hydro-Enforced bare earth DEM, building footprints, and 1-foot contours. The bare earth DEM is the product currently being used the most. Due to low ANPD, the building footprints do not pass the required Quality Control (QC). Christine Carlson, Lead Geospatial Scientist, SFWMD has raised concerns for the wetlands especially the impounded wetlands. SFWMD has conducted their own survey based QA/QC and issued a non-utilization document. Hence, there is a need for a priori corrections/adjustments that are to be set for the contract as well as tightening and modifications of specifications such as Minimum Mapping Units (MMU) for water bodies, stream and canal width, hydrologic connections such as culverts etc., in addition to the usual break lines such as bridges, roads, etc.

Justification and Critical Need:

Palm Beach County Administrator, Ms. Verdenia Baker, has mandated via memoranda the need for High Definition LiDAR and its utilization across various departments. The following areas require or would benefit from more current and higher resolution LiDAR.

Several existing projects and initiatives in PBC will benefit greatly from the availability of high quality LiDAR data.

1. Natural Areas - PBC owns or leases 48 square miles of natural areas to preserve rare and diverse native ecosystems and endangered, threatened and rare species of plants and animals.

2. Sea Level Rise - With Palm Beach County having some low-lying areas, high resolution elevation data will facilitate flood risk management and sea level rise studies.
3. Emergency Management - PBC's forty-five mile coastline is vulnerable to hurricanes and tropical storms. Effective storm surge modelling and evacuation route planning require accurate elevation data. Flooding risk also exists in low lying inland areas and the western regions bordering Lake Okeechobee along the United States Army Corps of Engineers (USACE) Herbert Hoover Dike.
4. National Flood Insurance Rate Maps – Updated elevation data will provide accurate Base Flood Elevations (BFE) and improved flood insurance rate determinations benefitting PBC businesses and residents.
5. National Flood Insurance Program Community Rating System (CRS) – Building footprints and Base Flood Elevations (BFE) can be derived from accurate high resolution LiDAR data.

Workflow

2016 LiDAR by Dewberry Inc.

1. **Figure 24 - Breakline QA/QC Workflow and Figure 25 – DEM Production Workflow**

illustrates the work flow and the process that were applied in the acquisition and processing of LiDAR data for Broward County, Florida. Palm Beach County is requiring a work product equal to or superior to the Broward County Work product. Note the list of computer software and Proprietary Tools and Scripts as they tie into the work flow. Palm Beach County expects that the provider will have extensive experience with the acquisition equipment and the processing tools required to generate LiDAR end products. Please list in detail your experience in utilizing each of the hardware, software, and proprietary scripts or tools on the list to create LiDAR end products.

2.

Elevation Data Processing-Breaklines

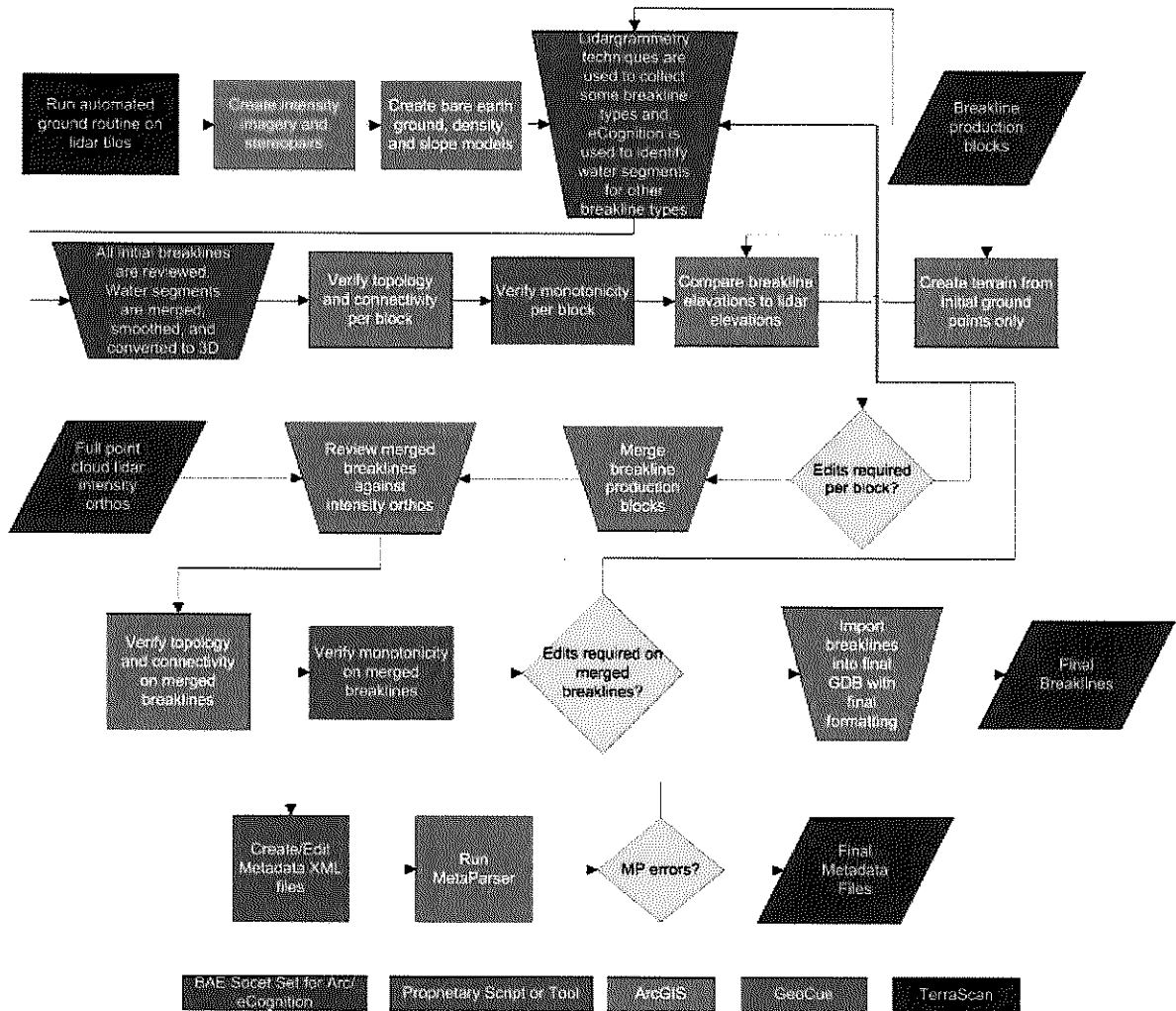


Figure 24 - Breakline QA/QC workflow

Critical Minimum Standards:

The anticipated PBC 2024 LiDAR must adhere to the following critical minimum standard:

- Shall meet all of the requirements of the USGS 3DEP Lidar Base Specification 2024 rev. A. Including ASPRS Positional Accuracy Standards for Digital Geospatial Data EDITION 2, VERSION 1.0 - August 23, 2023
- Scope shall include the supplier either providing an example of data collected with equipment meeting this solicitation requirements that meets the required resolution and vertical accuracy or shall provide a demonstration acquisition with equipment meeting this solicitation requirements.
- The supplier will verify that any deviation from the Elevation Data Processing-Breaklines Workflow or the DEM Production Workflow will not result in unwanted discrepancy in the final product; the bare earth Digital Elevation Model (DEM).
- The supplier will verify that any additional changing of the specifications will not adversely affect the final products (including Impervious Surfaces and Building Footprints). Each Building Footprint polygon elevation values derived by LiDAR (in US Survey feet - orthometric elevation) based on ground surface located nearest the Finished Floor Elevation (FFE) values.
- There should not be any deficiency in the methodology due to a lack of software, hardware or proprietary scripts and/or tools. Please contact Palm Beach County ISS/GIS to request authorization for different software, hardware, and proprietary tools and/or scripts. The Supplier is responsible for demonstrating any changes from 2016-2017 LiDAR process will result in a product that is equal or superior to Broward County's LiDAR.

Note: Refer to the PBC 2016-17 LiDAR Report by Dewberry Inc.

Additional minimal criteria for QL-1 Sensor

- The newest model of the Reigle dual-mode LiDAR platform with gyro-stabilized mounts shall be utilized in LiDAR collection to ensure that all of the QL-1 standards will be met.

- The collected full-wave form shall be downloaded as such and digitized later instead of onboard digitization. This would greatly increase the amount of on-board storage.
However, this is required as the county has areas with near 100% canopy closure (some areas of wetlands, sugarcane, etc.).
- Along with recording of the Full-wave form, the Pulse Rate Frequency (PRF) needs to be decreased to a practicable level for Canopy Penetration Index. Due to this adjustment the Aggregate Nominal Pulse Density (ANPD) shall be set at 12-14 points per square meter (PPSM) or higher.

Tightening of Specs:

- For water bodies in selected areas use a Minimum Mapping Unit (MMU) of greater than or equal to 0.50 acres (about 30 meters by 30 meters across).
- For building, the footprints greater than or equal to 50 square meters, including impervious areas such as driveways.
- Vertical Accuracy (both Vegetated and Non-Vegetated) meeting or exceeding ASPRS standards.

Concerns from 2016 LiDAR LAS files:

- TETRA TECH, a consultant on the Palm Beach County Vulnerability Assessment, brought to our attention exceptionally high noise in an area (see attached High_Noise_MTA_Explanation.pdf). Jose Barrero, Palm Beach County GIS Analyst, brought to our attention some building foot-prints that were not digitized. Samuel Rajasekhar, GIS Analyst investigated and traced the problem to high noise. The Reigle sensors seemed to exhibit significant errors in Multiple Time Around (MTA) laser pulses.

Equipment Concerns:

The low-density QL-2 LiDAR will be upgraded to high-density, high-quality QL-1 LiDAR sensors. The QL-1 LiDAR is expected to be collected at a minimum 12-14 ANPD per square meter to ensure compliance with minimum ANPD for QL-1. Also indicated by vendors is the assurance of QL-1 at higher Vertical Accuracy, both non-vegetated and vegetated categories. The sensors are in infrared band employing rotating mirror technology. Previous studies indicate that Geiger Mode LiDAR (GML) is unsuitable for QL-1 vertical accuracies even though the point density is commendable. The high point density of proposed 2024 LiDAR collection is ideal with a wide margin for mapping building foot prints which relies on specialized software and tools, as well as proprietary algorithms not only to extract building foot-prints but also the associated impervious areas at half the Minimum Mapping Units (MMU). This tighter specification is required for the 2024 LiDAR contract. All connected driveways and garages will be mapped along with the building footprint.

Wetlands are an integral and substantial part of PBC. Large areas of fresh-water wetlands were impounded for wildlife and other management practices. There are substantial estuarine wetlands along the Jupiter Inlet and Jupiter Creek. The wetlands are crisscrossed by creeks, man-made canals and dredged channels; as well as numerous naturally occurring open water ponds of varying sizes. These pose a great challenge to LiDAR mapping as the Infrared sensors does not reflect well off clear water. All of the laser energy is absorbed by the water column - this is exhibited by a Black Body effect. Shallow, turbid and vegetated water bodies produce erroneous results as well. Hydro-enforcement for 2016-17 LiDAR processing was performed by flattening the existing water-bodies coverage. Stream and canal coverage in line formats were not used for monotonically downhill flow. Because of these shortages, the SFWMD (Christine Carlson) has rejected the 2016/17 PBC LiDAR. SFWMD was a major partner for the USGS 3DEP grant. This anomaly is restricted to wetlands only, specifically where the water bodies were not mapped due to either Minimum Mapping Units (MMU), ambiguous wetland delineations, or scale and accuracy, etc. In the uplands, these issues were not encountered.

Specifications for LiDAR Sensor – 2024

- The Sensor must be current or optimally, the latest Reigle product.
- The Sensor must be a Dual Channel sensor to satisfy USGS 3-DEP criteria for terrestrial mapping at QL-1. The Full Waveform sensor and the data downloaded as full waveform (NOT digitized on board). This will require more storage.
- The platform must use a gyro-stabilized mount for optimal accuracy and compensate for the small flight disturbances.
- The Laser Penetration Index (LPI) shall be optimized to achieve additional returns in vegetated areas. The supplier shall select/adjust the Pulse Repetition Frequency (PRF) and other sensor adjustable such as power usage and flight altitude so a minimum ANPD of 12-14 (PPSM) will be achieved
- The DEM should be of High-Resolution, that is 1 foot or less Ground Sample Distance (GSD)

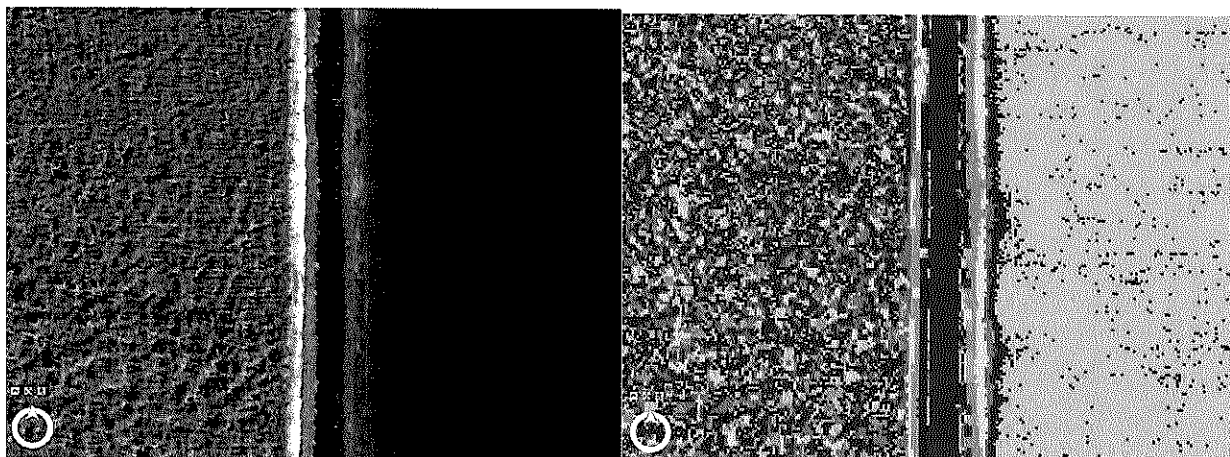
Tightening of Criteria for selected areas

- Hydro-Break lines – waterbodies of **0.5 acres** MMU (consultation with SFWMD) be delineated and input for Z-locked polygons. All streams, rivers, creeks, canals and ditches greater than **50 feet wide** (*per Paul Linton*) shall be mapped and input as dual line drains monotonically flowing downhill. Narrow streams, canals, drains, etc. shall be digitized as single line drains with varying elevations but monotonically flowing downhill.
 - Connectors – hydro-connectors such as pipes and culverts shall be input in deriving bare earth DEM. These are also important for modeling.
 - Add pumps & other lift stations added for hydro-enforcement.

*Karlín Alvan, Nayegandhi Amar & Patterson Keith. *‘Why Invest in High Density LiDAR?’*

Southwest Florida maps once, uses many times’. LIDAR Magazine. 02-12-202

Comparison of 2016 Palm Beach County LiDAR with 2023 Western Communities (Pilot Project)



Figures 1 & 2. On the left is the 2017 Aerial Photograph of an area in Western Communities selected because bare field adjoining a crop parcel. On the right is the bare earth DEM produced from QL-2 LiDAR (ANPD of 1.7 PPSM). Note that the bare soil is smooth and of lower elevation. The crop parcel shows much variation and is not smooth. Mapped at slightly higher elevation (color ramp from blue to red).

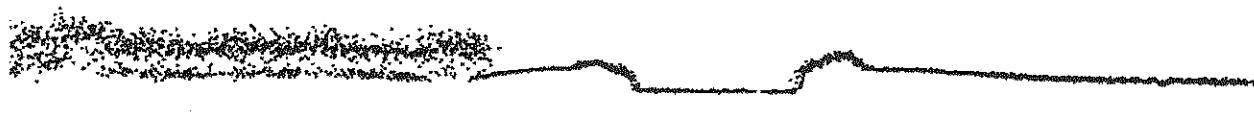
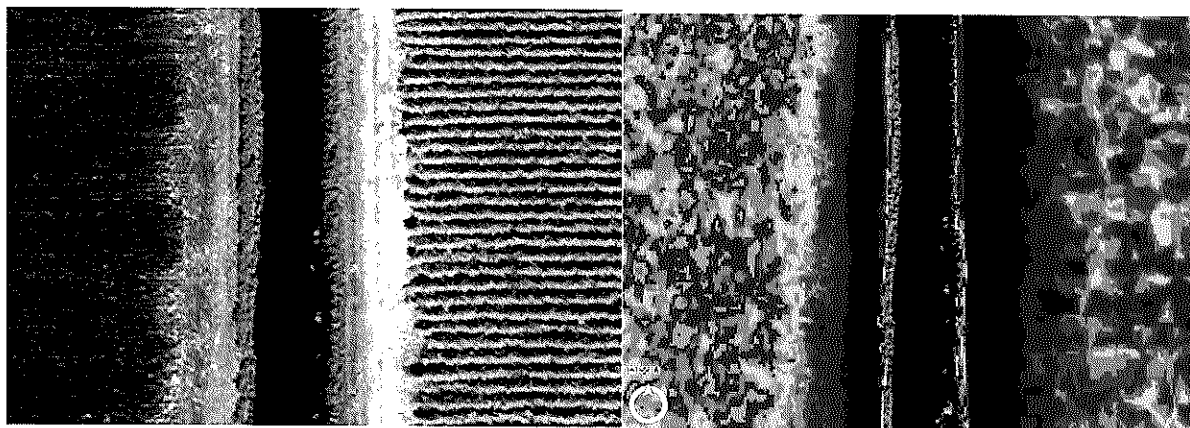


Figure 3. This is the vertical profile of a transect from crop canopy to harvested (from left to right). There are many second returns (in red). In the middle is the ditch (water filled). Either side has the elevated dykes. Note that there are practically no second returns from the bare soil (only first returns).



Figure 4. Same as Figure 3 - Note the ditch with aquatic vegetation (first returns likely from these) and dykes.



Figures 5 & 6. On the left is the 2023 Aerial Photograph of an area in Western Communities selected because bare field adjoining a crop parcel. On the right is the bare earth DEM produced from QL-1 LiDAR (ANPD of 20 PPSM). Note that the bare soil is not smooth (perhaps due to furrows) and is of lower elevation. The crop parcel is mapped at a slightly higher elevation (which is indicated on the color ramp from blue to red).



Figure 7. This is the vertical profile of a transect from harvested canopy to crop cover (illustration above from the left going to right). There are less second returns (red) than the 2017 LiDAR. This indicates that the platform and/or sensor used for 2023 Pilot Project is not desirable. In the middle is the ditch (water filled) and on either side the dykes. Note - that there are practically no second returns from the bare soil, only first returns.



Figure 8. Same as 6. Note the ditch with aquatic vegetation (these are first returns) and dykes.

Conclusion:

While PBC agreed that Reigle sensor for potential 2024 LiDAR, Additional consideration required:

1. The Full waveform returns downloaded instead of at-sensor calibration needs vast on-board storage.
2. An ANPD of 12-14 PPSM is sufficient. Increasing the LPI by decreasing the PRF may be necessary and is allowed as long as a minimum of 12 PPSM is achieved.
3. The Processing flow chart (Figure 25) considers second return bare earth algorithms for low vegetation.
4. The Dewberry Flow Chart (Figure 24) is the basic requirement: BAE's SOCETSET (& stereo workstation), E-COGNITION for GeoBia, TERRASCAN, etc., along with a robust and customized flow chart.

Expected Products & Accuracies

- Palm Beach County 2024 ASPRS Classified and processed LAS files
- Digital Elevation Model: 1 foot pixel that hydro-enforced, hydro-flattened and hydro-compliant (monotonous flow of water).
- Building footprints (including impervious areas)
- Pilot Project Area – Palm Beach County will specify a Pilot Project Area for data acquisition and processing that will be completed by the Geospatial Consultant. LiDAR data will be provided for the Pilot Project area to Palm Beach County for review and QA/QC of the LiDAR deliverables. If the specified standards are not met as specified, Palm Beach County reserves the right to reject the LiDAR deliverables.

Timeline

- 2025 January/February - LiDAR acquisition and accuracy assessment.
- 2025 March – Raw LiDAR Data delivery
- 2025 April through June - Processing of data and delivery of products for inspection

Businesses Units, Departments, and Processes Supported:

- County Administration
- Emergency Management
- Engineering & Public Works
- Environmental Resources Management

- Facilities Development & Operations
- Fire Rescue
- Information Systems Services
- Office of Resiliency
- Planning, Zoning & Building
- Property Appraiser Office
- Water Utilities Department

Author:

- Created by: D. Samuel Rajasekhar Date: 07/10/2024
- Updated by: D. Samuel Rajasekhar Date: 08/26/2024

Updates:

- Review and update by: Regina Hagger Date: 08/10/2024
- Review and update by: Regina Hagger Date: 09/04/2024
- Review and update by: Paul Linton Date: 09/16/2024

Questions:

- What is the expected vertical accuracy in hard surfaces (e.g. concrete)?
- What is the expected vertical accuracy in lawn areas?
- What is the expected vertical accuracy in vegetated areas?
 - For all 3 of these I would follow the USGS Lidar Base Spec for QL1 Data
 - Smooth surface precision, RMSDV $\leq 0.06M$
 - Swath overlap difference RMSDV $\leq 0.08M$
 - Absolute vertical accuracy for LIDAR and DMS $\leq 0.100M$ RMSEv (Nonvegetated)
 - Vertical accuracy in lawn areas should still meet the required 10 cm vertical accuracy class
 - Vegetated vertical accuracies are **target accuracies** and will not have a pass or fail requirement per the USGS spec.
- How many vertical control points will be included?
 - Vertical control points will be dependent on the number flightlines, sensor, and layout. NVA and VVA will follow the most recent ASPRS guidance.
- Will increasing the number of vertical control point improve the vertical accuracy and if so how?
 - Lowering the flying height will increase the vertical precision and will require additional control due to the increased number of flight lines.
- PBC would like to expedite production of the ground individual ground surface elevation to support FEMA remapping around Lake Okeechobee. Providing LiDAR point elevation by February is desired. Is this possible?
 - It all dependent on when a notice to proceed is provided.
- PBC wants results of equal or better quality than what was produced for Broward County.
 - Understood

- PBC is seeking input on how to get better LiDAR penetration (additional returns) in vegetated areas.
 - Lower flying height and increase point density. If the veg canopy is very dense and present year-round there might not be much that can be done.
 - Increasing side lap and providing 55% overlap may yield more density under the canopy much like a forestry application, however the trade off for acquisition cost versus actual penetration in these areas may not be worth it. If light cannot penetrate the dense canopy, the laser will not no matter the plan.

