**QA LiDAR Process**

1. Review hard drive from Sanborn to make sure all the deliverables are included.
	1. Raw Point Cloud File
	2. Classified LAS Files
	3. Bare Earth DEM
	4. ASCII Grid files
	5. Breaklines
	6. Intensity Images
	7. Metadata
	8. Shapefiles ex. Tiles
	9. Control Point File (Excel or CSV file)
2. Add LAS files to LP360. Add the entire county wide file

**Determine Statistical Information**

**1.** Create a new PCT for a statistical analysis by selecting **ADD TASK**

a. Under Class type select Point Cloud Statistics Extractor.

b. Under Task Name call the task LAS Statistics.

**2.** Determine the statistics for all points on a per file basis.

a. Under the General Tab check the box for Extract by Files and select the following:

i. Point Count

ii. Point Density

iii. Number of Flightlines

iv. Point Count/Class

v. Number of Return Numbers

vi. Area

b. Under the Point Attributes Tab select the following:

i. Intensity (Min, Avg, Max)

ii. Return Number (Min, Avg, Max)

iii. Scan Angle (Min, Avg, Max)

c. Under the Header Attributes Tab select all the attributes

d. Output shapefile using the Project Path

i. Project Path defaults to the location of the LIDAR data, it can be changed via the LP360 dropdown. Specify the project Path as the Training Exercise Folder

e. Output the file using the Project Path

i. <LP360\_PROJECT\_PATH>\<PROJECT\_FOLDER>\County\_LAS\_Statistics.shp

1. The folder does not need to exist yet in order to accomplish this.

ii. Check the box to **ADD TO MAP**.

f. Click **APPLY**.

g. Select the button to **EXECUTE TASK FOR A PROJECT**

**3.** Determine statistics using only the first return points on a per file basis.

a. Under the General Tab check the box for Extract by Files

i. Select the **SOURCE POINTS** button

1. Select Return Combinations

a. Under the drop down menu pick First Return

2. Select Scan Angle

a. Filter based on Scan Angle

i. Minimum -11

ii. Maximum 11

b. For Extraction Items select: Point Count, Point Density and Area.

c. Output the file using the Project Path

i. <LP360\_PROJECT\_PATH>\<PROJECT\_FOLDER>

\County\_LAS\_Statistics\_FR.shp.

ii. Check the box to **ADD TO MAP**.

d. Click **APPLY**.

e. Select the button to **EXECUTE TASK FOR A PROJECT**.

**4.** Use the stamp tool to sample numerous small sections of interest. These areas should be selected on the basis of not containing any acceptable data holidays due to water, dark asphalt, etc.

a. Copy the Statistics Filter and name the new filter AOI Stamp Statistics

b. Change the filter so that it is not extracting on a file basis

i. Uncheck Extract By Files

ii. Output the file using the Project Path

1. <LP360\_PROJECT\_PATH>\<PROJECT\_FOLDER>\County\_Stamp\_Statistics.shp

2. Check the box to **ADD TO MAP**.

iii. Click **APPLY**.

c. You can make the stamp bigger or smaller by using the “arrow” keys on the numeric keypad.

d. Experiment with different sized stamps to compare the results.

**Generate Point Density Image**

**1.** Create a Point Density Tiff Image

**2.** Click the **EXPORT LIDAR DATA** Command

a. Set the parameters for Step 1 of the Export Wizard to the following settings:

i. Export Type is Surface.

ii. Set the Filter

1. Select Return Combinations

a. Under the drop down menu pick First Return

2. Select Scan Angle

a. Filter based on Scan Angle

i. Minimum -11

ii. Maximum 11

iii. Set the Surface Method as Point Insertion, with a cell size that is 2 times the Nominal Pulse Spacing that was determined in Section I.

iv. Under Attributes select Point Density.

v. On the Density Tab set the Point Density value as the inverse of the cell size.

1. For instance if Cell size is equal to 2.8 then Point Density is equal to 1 divided by 2.8, or 0.35

2. This value is used to determine if there is at least one LIDAR point per pixel cell

vi. Set the Units to meter and pick an interval of 4

1. If desired, change the color of the intervals

b. Step 2 is used to define the extent of the exported surface based off the loaded LIDAR Data.

i. Choose the option for Basic Extent: Draw Window in Map

1. For the sake of time try not to pick more than 6 tiles

c. Complete Step 3 of the Export Wizard by using the Browse command to navigate to training exercises location.

d. Call the file NPS, check the box to Insert Output(s) to Map and click the Finish command and wait for the export to be completed.

**Relative Accuracy Assessment**

**Generate dZ Orthos**

**1.** Click the **EXPORT LIDAR DATA** Command

a. Step 1

i. Export Type is Surface.

ii. Set the Filter

1. Select All Classifications and returns

iii. Set Surface Method as Point Insertion, with a cell size of 5.

iv. Under Attributes select dZ images.

v. Under the Dz Tab set the interval size as 0.04.

1. The purpose of the dZ image is to check the swath-to-swath relative accuracy based upon the vertical accuracy class. In this case 10 cm, which means a max difference of 16 cm in non-vegetative areas.

vi. Pick an interval of 5

1. If desired, change the color of the intervals

b. Step 2 is used to define the extent of the exported surface based off the loaded LIDAR Data.

i. Choose the option for Basic Extent: Draw Window in Map

1. For the sake of time try not to pick more than 6 tiles

c. Complete Step 3 of the Export Wizard by using the Browse command to navigate to your LiDAR Folder. Create a folder called <County>Relative\_Accuracy\_Assessment.

d. Call the file dZ, check the box to Insert Output(s) to Map and click the Finish command and wait for the export to be completed.

**Swath-to-Swath Analysis**

**1.** In order to perform the swath-to-swath analysis one must have a polyline feature class that defines where to perform the analysis. To create this feature:

a. Open **ARCCATALOG** from within ArcMap

b. Right-click on the folder containing your LiDAR and select **NEW** **SHAPEFILE**

c. Name the shapefile, “Swath-to-Swath\_Analysis.shp”

d. Set the Feature Type to Polyline

e. *Optional:* Define the Spatial Reference to match the LIDAR data (Click the **EDIT** button)

i. Projected Coordinate Systems UTM NAD 1983NAD 1983 UTM Zone 16N

**2.** Once the feature class has been created the next step is to draw in the lines indicating where to perform the seamline analysis. These need to be drawn on either side of the “overlap”, in areas of open terrain only.

a. Change the **LEGEND** to view by **POINT SOURCE**

b. Start an Editing Session from the ArcGIS Editor Toolbar for the “Swath-to-Swath\_Analysis.shp” feature file.

c. Draw a line on either side of the area between flight lines where the data overlaps.

i. There should be two adjacent polylines for each overlap area

d. Continue creating Seamlines until all overlap areas are identified

e. Close the Editing session and save your Edits

**3.** Select the **SEAMLINE ANALYSIS** tool on the LP360 QA/QC Toolbar

**4.** Set the following parameters

a. Sample Distance: 100

b. Search Radius: 3

c. Check the box to Omit no-data from Outputs

d. Modify Point Filter: Use Classes 1, 2, and 8

e. Output File: Give the file a base name. This process creates two shapefiles as the end result.

f. Click Analyze

g. Add the results to ArcMap.

**5.** View the residuals (Samples) by Graduated Symbols.

a. Select Properties on the Point Shapefile

b. Select the Symbology Tab

c. Select Quantities Graduated Symbols

i. Value: dZ2\_1

ii. Normalization: None

iii. Set Classes: 5

iv. Symbol Size from 4 to 14

v. Change the color of each symbol to go from red to blue (red, orange, yellow, green, blue) by double clicking on each symbol

d. Click OK

**6.** Take a look at some of the residuals that are in the red or blue range. These will be residuals that are outside the norm. Draw profiles around these points. Can you see why these values might be out? Are they in low lying vegetation? If necessary, modify the lines for analysis and rerun.

**7.** From the resulting values determine the suitability of the dataset for the desired accuracy class.

**Absolute Accuracy Assessment**

**Non-Vegetated Vertical Accuracy (NVA)**

**1.** Open LP360 for ArcGIS, or LP360 for Windows

**2.** Add the LP360, LP360 Viewer Integration and LP360 Control Points Toolbars.

**3. ADD** an imagery file if needed.

**4. ADD** the LAS Files.

**5.** Create a Control Point Shapefile from the Control Point CSV file

a. **LP360** **IMPORT** **IMPORT ASCII ‘XYZ+’ POINT FILES WIZARD** (LP360 for ArcGIS), or **FILE** **IMPORT ASCII ‘XYZ+’ POINT FILES WIZARD** (LP360 for Windows)

b. Step 1

i. Output Format: Shapefiles

ii. Add: Browse and select the Control\_Point.csv file

iii. Output File: Output to the same directory

c. Step 2

i. Delimited

ii. Start Import at line: 2

d. Step 3

i. Check Comma

e. Step 4

i. Column 1: Name

ii. Column 2: X/Easting Coordinate

iii. Column 3: Y/Northing Coordinate

iv. Column 4: Z/Elevation Coordinate

v. Column 5: Type

f. Click Finish

g. Add the resulting shapefile to ArcMap

**6.** Set the **TARGET CONTROL POINTS FEATURE CLASS** to the Control Points file created above.

**7.** Set the **ELEVATION FIELD** to Shape.

**8.** Zoom to a single control point at a map scale that allows you to see the control point and surrounding features (e.g. 1:1,000).

**9.** Turn on the **PROFILE WINDOW**. Notice how the three dimensional location of the control point is displayed in the Profile Window as a circle with a red X.

**10.** Use the **NAVIGATION TOOLS** to navigate the control points. with Drive Mode set to ALL

**11.** Open the **CONTROL POINTS REPORT DIALOG**.

a. Set the Source Points to Ground Class and Model Keypoints (2 and 8).

b. Set the Surface Interpolation Method to TIN in the Method group box.

c. Z Probe Location: Control X,Y

d. Click the **CALCULATE DZ** command to calculate the control point statistics.

**12.** Examine the Output Summary group box to determine how many control points returned no-data.

**13.** Determine any outlier points by filtering the error column to sort the errors in descending order and left click again on the Error column to sort the errors in ascending order. Notice how any of the fields can be sorted in ascending or descending order by left clicking on the field of interest.

**14.** Turn Outliers Off/On by clicking on the checkbox next to the outlier(s) you wish to turn off. Notice how the statistics are re-calculated on the fly when you toggle outliers.

**15.** Zoom to a control point that is highlighted in red, which is indicating that the control point does NOT meet the NVA requirement. To examine the control point further, double click on the control point’s row in the list to zoom to that control point in the map and in the profile.

**16.** With the desired outliers turned off export the report to a text file by left clicking on the **EXPORT REPORT** command. Output the report to a directory where you have read write permission. Open the report and examine its contents.

**Manual QA/QC Process**

1. Review all the automated processes that were ran in the previous sections.
2. Look for missing data within tiles
	1. Load entire county LAS dataset into ArcMap or LP360
	2. Load all Intensity Images into ArcMap or LP360
	3. Turn both layers on and look for areas where there are LAS points and no images.
		1. If missing information on images note which ones to be looked at for further investigation

**Review for classification errors**

Select around 25 to 30 tiles in different areas (near water, cities, bridges, forests, and open areas)

**1.** Set the Legend Type to Display by Classification.

**2.** Set the Draw type to Display Points on Surface (TIN or Wireframe).

a. Create a New Filter

b. Name the Filter QA/QC

c. Set the Display Filter to show all points, except for Ground and Model Keypoints (2 and 8)

d. Set the TIN Filter to show Ground and Model Keypoints only (2 and 8)

**3.** Create some ArcGIS Hot Keys (only possible in LP360 for ArcGIS)

a. Go to Customize Customize Mode in the main ArcGIS Menus

b. Click on Keyboard

c. Under Categories select LP360

d. Specify **Add Circle Area**

i. Under Press new shortcut key on the keyboard select Ctrl+Alt+C

ii. Then press assign

e. Specify **Add Polygon Area**

i. Under Press new shortcut key on the keyboard select Ctrl+Alt+P

ii. Then press assign

f. Specify **Add Rectangle Area**

i. Under Press new shortcut key on the keyboard select Ctrl+Alt+R

ii. Then press assign

g. This will create three new hot keys which will be used during the exercise

**4.** Use the **CREATE QA/QC FEATURE CLASS** command found on the LP360 QA/QC Toolbar to create the QA/QC feature class in the exercise directory.

a. Name the file <County>\_QA\_QC.shp

**5.** Set the Target QA/QC Feature Class to the file that you just created.

**6.** Review potential errors in the Profile and 3D Viewer Windows.

a. Sync the windows together

b. Set the **3D VIEWER WINDOW** to use the same legend and display as the **MAIN WINDOW**

i. Set the Legend Type to Display by Classification.

ii. Set the Draw type to Display Points on Surface (TIN or Wireframe).

1. Open the LAS Properties

2. Set the Display Filter to show all points, except for Ground and Model Keypoints

3. Set the TIN Filter to show Ground and Model Keypoints only

**7.** Use the Hot Keys created earlier to annotate errors. Once selecting the hot key draw over the area in question to start the annotation portion.

a. If running in LP360 for Windows use the **ADD ISSUE TOOLS** instead

**8.** Try creating a new **ISSUE TYPE** to use during the QA/QC session.

**9. EDIT AN ISSUES ATTRIBUTE** to add a comment or modify the **ISSUE TYPE**.

**10. DELETE** an issue.