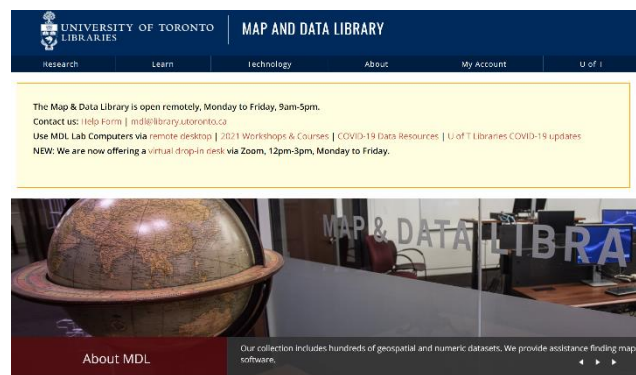


Using Lidar Data in ArcGIS Pro



*February 25, 2021, 2:00pm, presented by
Gerald Romme, GIS Analyst, Map and Data
Library*

<https://mdl.library.utoronto.ca/>





UNIVERSITY OF TORONTO MAP & DATA LIBRARY

Metadata Page from Toronto 2015 Lidar data

LiDAR Project Summary



Airborne Imaging
5757 4th Street SE
Calgary, Alberta, Canada
T2H 1K8

Telephone: (403) 215 2960
Fax: (403) 258 3189
www.airborneimaginginc.com

Project Information

Project Name:	Toronto
Project Number:	13968
Client:	Ontario Council of University Libraries
Project Type:	Wide Area
Project Location:	Toronto, Ontario, Canada
Project Size:	641.45 sq km

Acquisition Projects

Project Name	Project Number	Vintage
GTA2015	1453	April 2015

Acquisition Parameters

Date (MM/DD/YY)	Mission	Flying Height (m)	Flying Speed (knots)	Pulse Rate Rep (kHz)	Scan Freq (Hz)	Scan Angle (degree)	Side Lap %	Point Density (pts/m ²)	LiDAR System
04/06/15	7915096a	1300	160	400	52	40	50	10.0	Leica ALS70
04/07/15	7915097a	1300	160	400	52	40	50	10.0	Leica ALS70
04/11/15	7915101a	1300	160	400	52	40	50	10.0	Leica ALS70
04/25/15	7915115b	1300	160	400	52	40	50	10.0	Leica ALS70
Multiple Return Capabilities:		YES		Number of returns recorded:		Maximum 4			

Geodetic Control

Horizontal Datum:	Nad83 CSRS	Vertical Datum:	CGVD28
Geoid Model:	HT2.0	UTM Zone:	17
Note: We established a local geodetic network fixed to the following control:			
Station ID	Lat	Long	Ellp Height
61313	43 46 05.44812	-79 38 49.15723	154.971
653196	43 35 30.99772	-79 36 11.54776	92.610

Calibration Methodology

Airborne Imaging performs a complete calibration on every LiDAR acquisition flight, data is acquired over a calibration site flown with at least two passes in opposite directions before and after the flight. Any error in the attitude of the aircraft (roll, pitch and heading) can be observed and corrected for within system specifications. To statistically quantify the accuracy, we compare the LiDAR elevations with independently surveyed ground points. A GPS mounted truck collects data while driving on an open road. The kinematic positions on the road are post-processed from a nearby base station (common to the aerial survey)

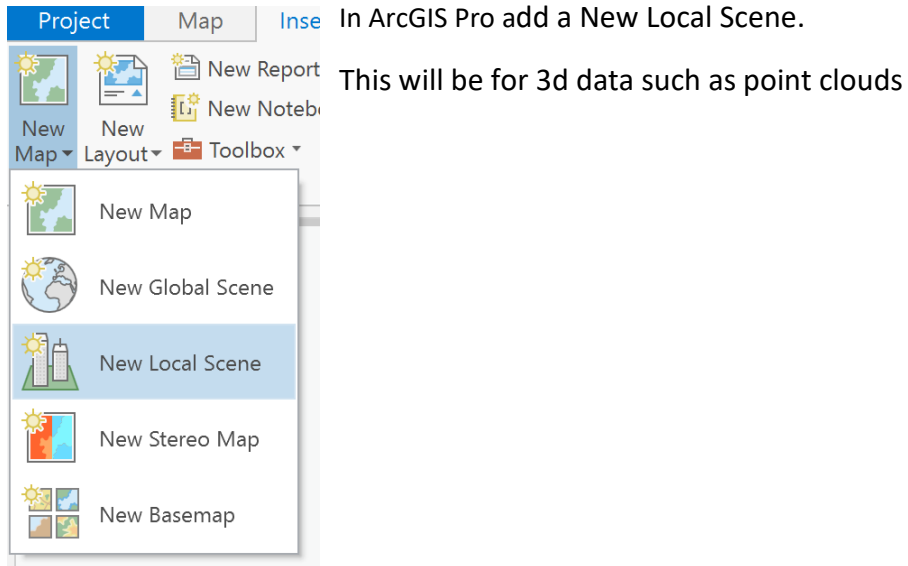
Accuracy

Horizontal Accuracv. 95% or 2σ: 30 cm

Deliverables

1m Grids (XYZ ASCII), Bare Earth and Full Feature
Hillshade Images (Geotiffs), Bare Earth and Full Feature
Point Cloud (LAS v1.2, ASPRS Classes)
50cm Contours (shp)
Metadata (.pdf format, LiDAR Summary)

Summary Produced: April 5, 2017



Projection information from the metadata showing vertical and horizontal coordinate systems used for LAS Datasets

Geodetic Control			
Horizontal Datum:	Nad83 CSRS	Vertical Datum:	CGVD28
Geoid Model:	HT2.0	UTM Zone:	17
Note: We established a local geodetic network fixed to the following control:			
Station ID	Lat	Long	Ellp Height
61313	43 46 05.44812	-79 38 49.15723	154.971
653196	43 35 30.99772	-79 36 11.54776	92.610

The American Society for Photogrammetry & Remote Sensing

Classification codes: LAS format 1.1 - 1.4

If you are working with LAS 1.1 - 1.4 specification, refer to the predefined classification schemes defined by the American Society for Photogrammetry and Remote Sensing (ASPRS) for the desired data category. The following table lists the LAS classification codes defined by ASPRS for these LAS versions:

Classification value	Meaning
0	Never classified
1	Unassigned
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point
8	Reserved *
9	Water
10	Rail
11	Road Surface
12	Reserved

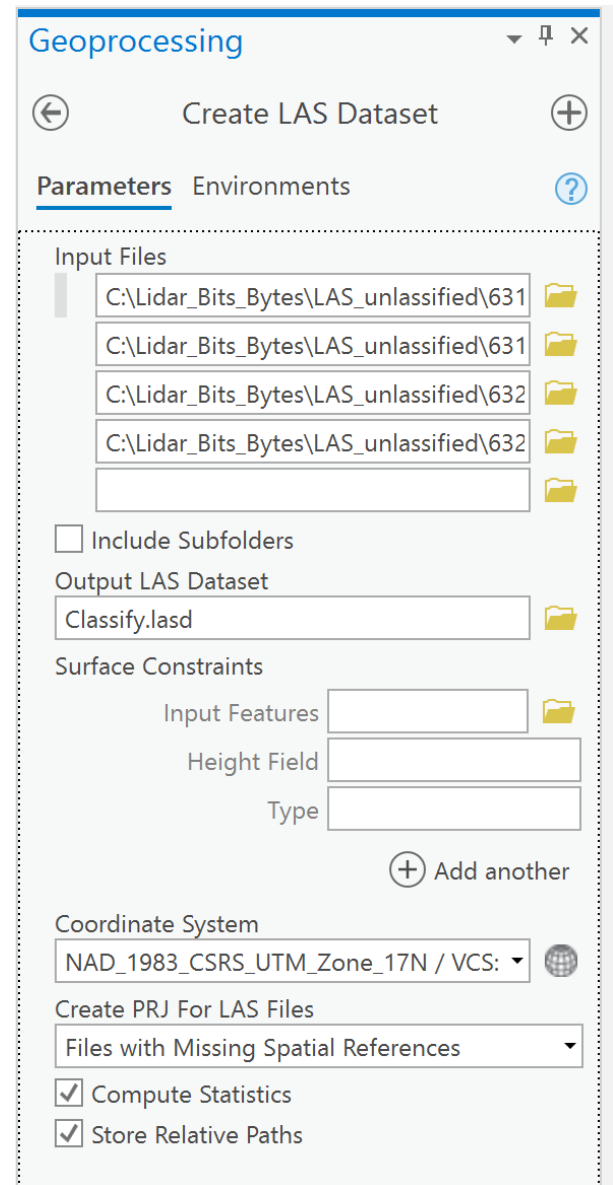
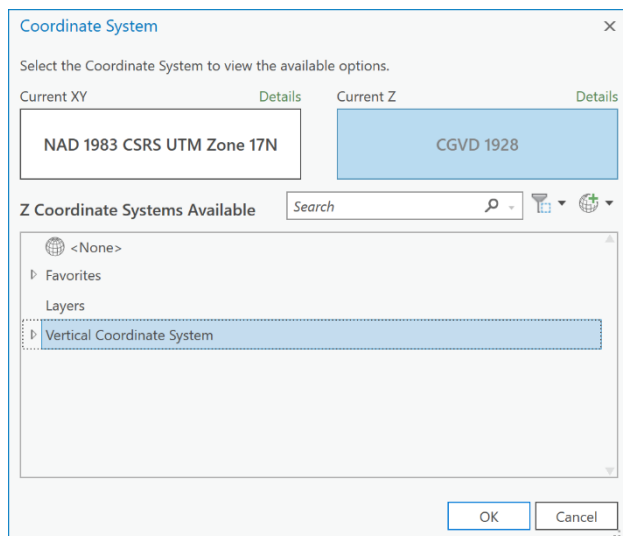
<https://desktop.arcgis.com/en/arcmap/10.3/manage-data/las-dataset/lidar-point-classification.htm>



Create an LAS Dataset

Add las file which are classified.

Assign the vertical and horizontal projections.



Viewing LASD Properties

LAS File Properties: Classify.lasd

General
Statistics
LAS Files
Surface Constraints
Pyramid
Coordinate System

Statistics

Classification Codes	Attributes	Returns	Classification Flags				
Classification	Point Count	%	Z Min	Z Max	Min In	Max In	Synthe
1 Unassigned	1,047	0.01	112.69	121.17	0	65535	0
2 Ground	4,604,039	34.93	75.40	123.37	0	1552	0
3 Low Vegetation	3,076,076	23.34	75.50	127.27	0	1646	0
4 Medium Vegetation	219,559	1.67	76.18	128.15	0	1646	0
5 High Vegetation	5,281,378	40.06	77.02	201.09	0	1653	0
7 Noise	35	0.00	75.84	120.79	0	65535	0

Update ☐ Force recalculate

Statistics up to date.

OK Cancel

In Catalog right click on the lasd. Click on Statistics and this will show Classification codes as well as other information about the las dataset.

LAS File Properties: Classify.lasd

General
Statistics
LAS Files
Surface Constraints
Pyramid
Coordinate System

Files

Show: Files ☐ Show full path of LAS files

Add Files... Add Folders... Remove

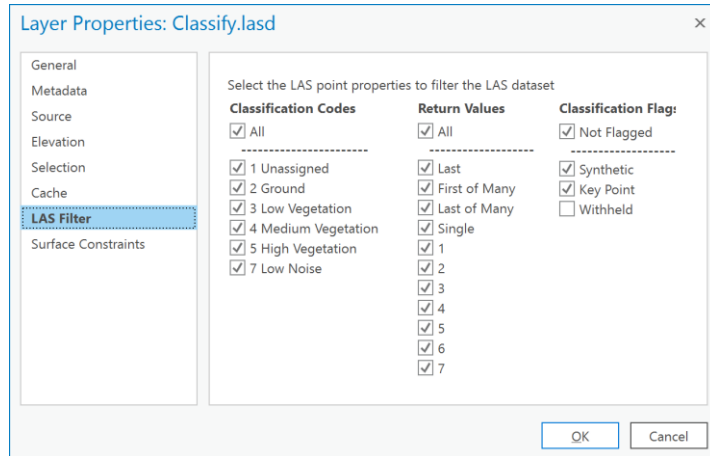
LAS File	Version	Point Count	Point Spacing	Z Min	Z Max	Details
6320_48380.las	1.2	3,505,362	0.263	76.54	201.09	...
6315_48375.las	1.2	3,180,945	0.275	75.4	143.23	...
6315_48380.las	1.2	3,006,054	0.281	76.52	147.37	...
6320_48375.las	1.2	3,489,773	0.264	78.52	188.87	...

OK Cancel

Click on LAS Files and this will show the LAS files which were added to the LASD. The Point Spacing is also shown which will be used for creating raster data.

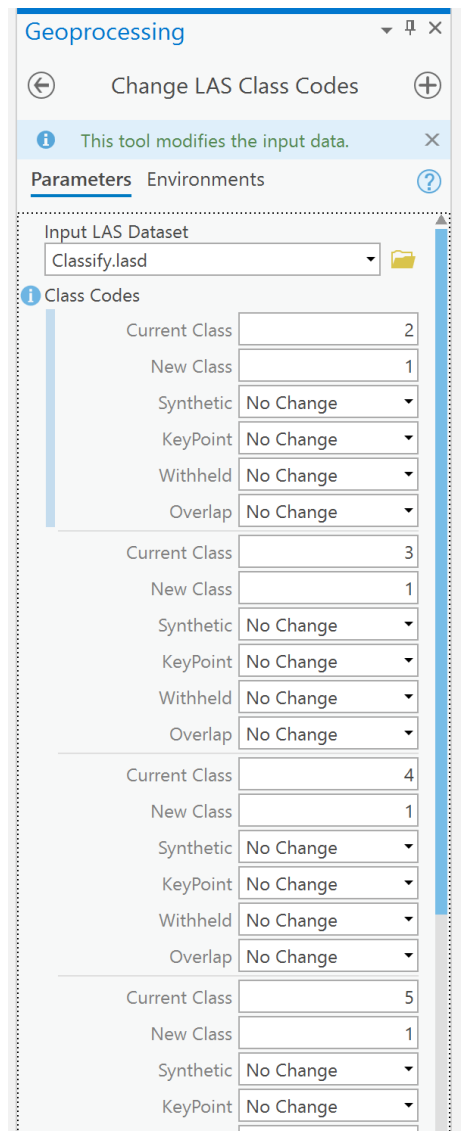
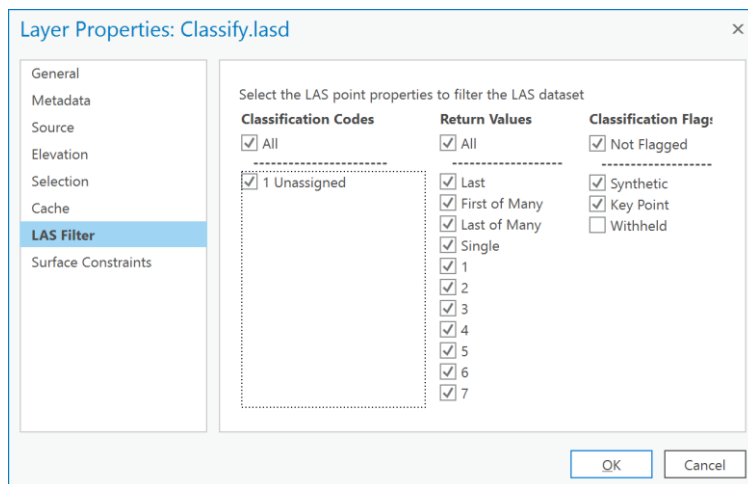
Reclassify LAS Dataset

In the LAS Dataset, in the contents pane, right click on the file and open the properties. Click on LAS Filter.



Change all LAS Codes to 1 using Change LAS Codes.

All Classes are now 1.

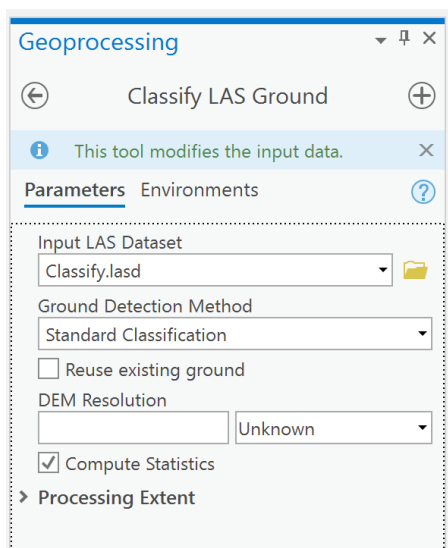




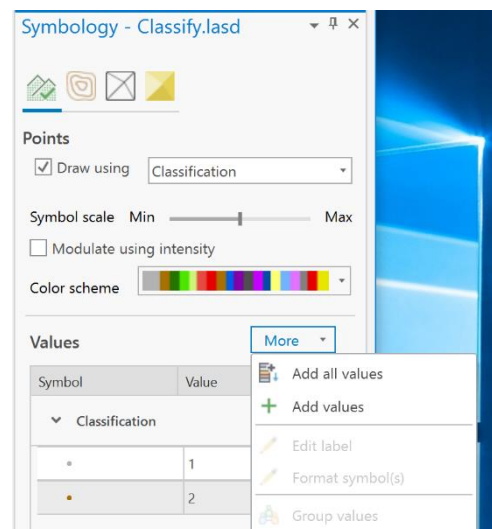
Unclassified Data



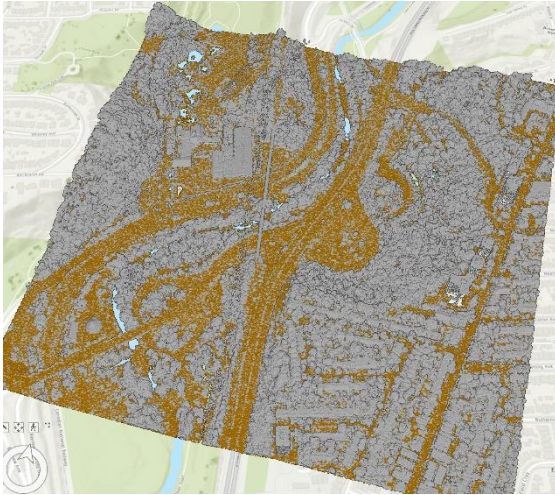
Use Classify LAS Ground to classify the ground. The classification code for ground is 2.



Once the Classify Ground has been run go to symbology to add all values

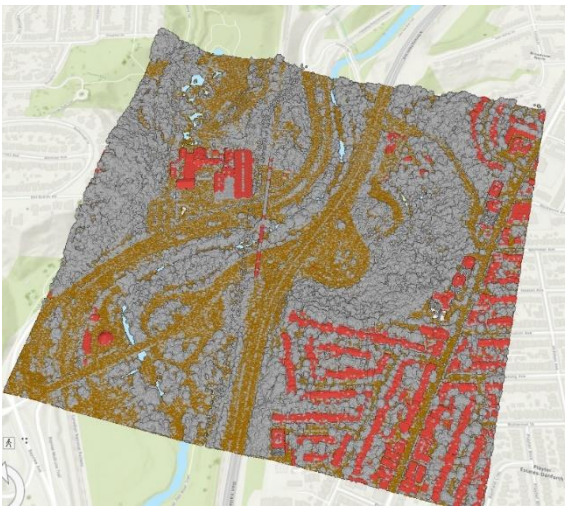


Ground Classified



Classify buildings using the Classify LAS Building tool

Buildings classified



Geoprocessing ▾ 📌 ✕

⬅ **Classify LAS Building** ⊕

i This tool modifies the input data. ✕

Parameters **Environments** ?

Input LAS Dataset
Classify.lasd 📁

Minimum Rooftop Height
 Meters ▾

Minimum Area
 Square Meters ▾

Classification Method
Standard ▾

☐ Reuse existing building classified points

☐ Is photogrammetric data

☒ Compute Statistics

▼ **Above-Roof Classification**

☒ Classify points above the roof

Maximum Height Above Roof
 Meters ▾

Above Roof Class Code

▼ **Below-Roof Classification**

☒ Classify points below the roof

Below Roof Class Code

▼ **Processing Extent**

Processing Extent ▾

Processing Boundary 📁 ✎ ▾

☐ Process entire LAS files that intersect extent



Geoprocessing

← Classify LAS By Height →

This tool modifies the input data.

Parameters Environments

Input LAS Dataset
Classify.lasd

Ground Source
All Ground Points

Height Classification

Class Code	Height
3	5
4	25
5	50

Noise Classification
None

☒ Compute Statistics

Processing Extent

Classify Vegetation using the Classify LAS By Height tool



New Classification Codes

Layer Properties: Classify.lasd

General
Metadata
Source
Elevation
Selection
Cache
LAS Filter
Surface Constraints

Select the LAS point properties to filter the LAS dataset

Classification Codes	Return Values	Classification Flags
<input checked="" type="checkbox"/> All	<input checked="" type="checkbox"/> All	<input checked="" type="checkbox"/> Not Flagged
<input checked="" type="checkbox"/> 1 Unassigned	<input checked="" type="checkbox"/> Last	<input checked="" type="checkbox"/> Synthetic
<input checked="" type="checkbox"/> 2 Ground	<input checked="" type="checkbox"/> First of Many	<input checked="" type="checkbox"/> Key Point
<input checked="" type="checkbox"/> 3 Low Vegetation	<input checked="" type="checkbox"/> Last of Many	<input type="checkbox"/> Withheld
<input checked="" type="checkbox"/> 4 Medium Vegetation	<input checked="" type="checkbox"/> Single	
<input checked="" type="checkbox"/> 5 High Vegetation	<input checked="" type="checkbox"/> 1	
<input checked="" type="checkbox"/> 6 Building	<input checked="" type="checkbox"/> 2	
	<input checked="" type="checkbox"/> 3	
	<input checked="" type="checkbox"/> 4	
	<input checked="" type="checkbox"/> 5	
	<input checked="" type="checkbox"/> 6	
	<input checked="" type="checkbox"/> 7	

OK Cancel

Reclassify By Feature

The original LAS data does not contain buildings



Layer Properties: reclassBLD.lasd

Select the LAS point properties to filter the LAS dataset

Classification Codes	Return Values	Classification Flag:
<input checked="" type="checkbox"/> All	<input checked="" type="checkbox"/> All	<input checked="" type="checkbox"/> Not Flagged
<input checked="" type="checkbox"/> 1 Unassigned	<input checked="" type="checkbox"/> Last	<input checked="" type="checkbox"/> Synthetic
<input checked="" type="checkbox"/> 2 Ground	<input checked="" type="checkbox"/> First of Many	<input checked="" type="checkbox"/> Key Point
<input checked="" type="checkbox"/> 3 Low Vegetation	<input checked="" type="checkbox"/> Last of Many	<input type="checkbox"/> Withheld
<input checked="" type="checkbox"/> 4 Medium Vegetation	<input checked="" type="checkbox"/> Single	
<input checked="" type="checkbox"/> 5 High Vegetation	<input checked="" type="checkbox"/> 1	
<input checked="" type="checkbox"/> 7 Low Noise	<input checked="" type="checkbox"/> 2	
	<input checked="" type="checkbox"/> 3	
	<input checked="" type="checkbox"/> 4	
	<input checked="" type="checkbox"/> 5	
	<input checked="" type="checkbox"/> 6	
	<input checked="" type="checkbox"/> 7	

OK Cancel

Use the Set LAS Class Codes using Features tool

Geoprocessing

Set LAS Class Codes Using Features

This tool modifies the input data.

Parameters Environments

Input LAS Dataset
reclassBLD.lasd

Input Feature Class
Features: buildings

Buffer Distance: 0

New Class: 6

Synthetic: No change

KeyPoint: No change

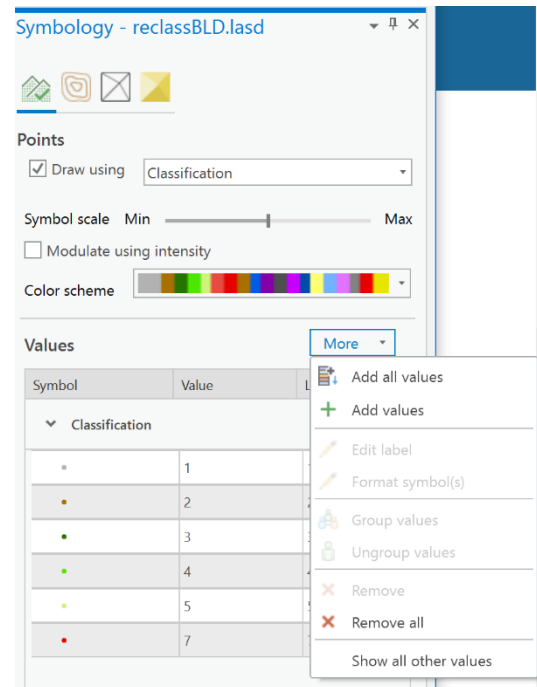
Withheld: No change

Overlap: No change

Compute Statistics

Add another

To add the new classified buildings click more then add all values



Classified buildings



New classification codes

Select the LAS point properties

Classification Codes

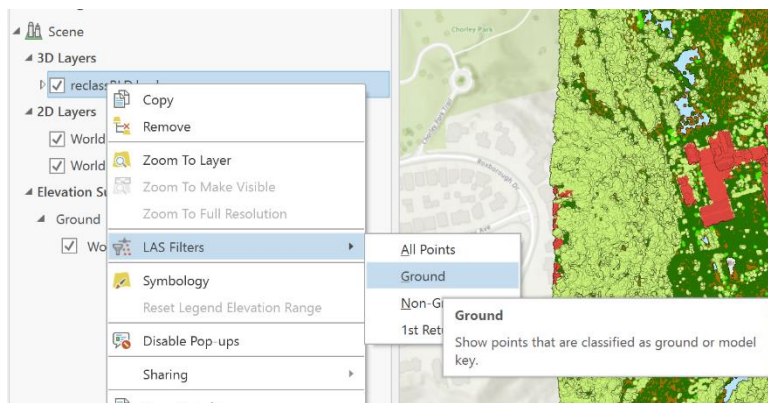
☒ All

- ☒ 1 Unassigned
- ☒ 2 Ground
- ☒ 3 Low Vegetation
- ☒ 4 Medium Vegetation
- ☒ 5 High Vegetation
- ☒ 6 Building
- ☒ 7 Low Noise

Create DEM

Symbolize ground points.

Right click on the LAS Dataset in the table of contents, click on LAS Filters then Ground



Ground points symbolized in the LAS Dataset

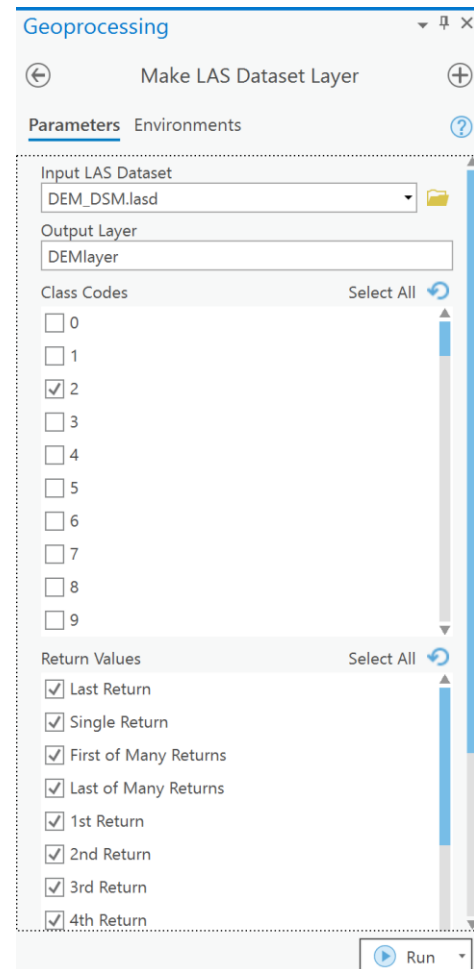


Create a Ground (DEM) LAS Dataset

Use the Make LAS Dataset Layer tool.

Check off the class code of 2 for ground and then select all Return Values

This will create an LASD of only the ground points.



Geoprocessing

Make LAS Dataset Layer

Parameters Environments

Input LAS Dataset
DEM_DSM.lasd

Output Layer
DEMLayer

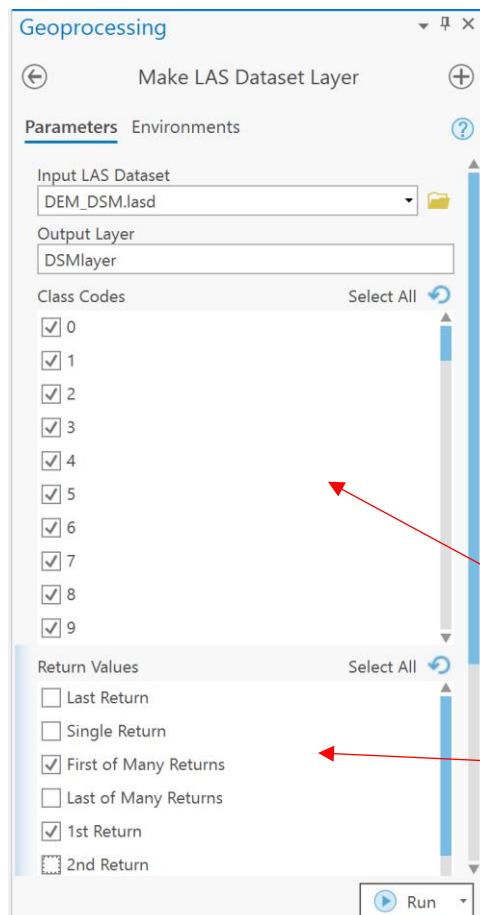
Class Codes Select All

☐ 0
☐ 1
☒ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9

Return Values Select All

☒ Last Return
☒ Single Return
☒ First of Many Returns
☒ Last of Many Returns
☒ 1st Return
☒ 2nd Return
☒ 3rd Return
☒ 4th Return

Run



Geoprocessing

Make LAS Dataset Layer

Parameters Environments

Input LAS Dataset
DEM_DSM.lasd

Output Layer
DSMLayer

Class Codes Select All

☒ 0
☒ 1
☒ 2
☒ 3
☒ 4
☒ 5
☒ 6
☒ 7
☒ 8
☒ 9

Return Values Select All

☐ Last Return
☐ Single Return
☒ First of Many Returns
☐ Last of Many Returns
☒ 1st Return
☐ 2nd Return

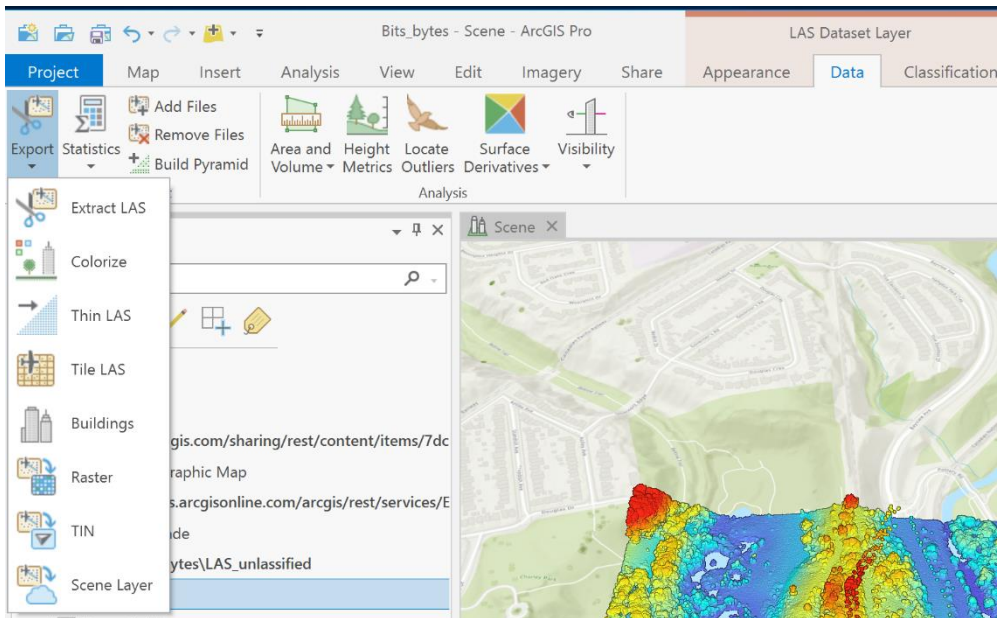
Run

Create a Digital Surface Model (DSM) LAS Dataset

Use the Make LAS Dataset Layer tool.

Select all Class Codes then the return values of First of Many Returns and 1st Return. This will give the first object the lidar hits. It will give tree tops as well as ground.

Create a DEM and DSM raster. Click on the LAS Dataset Layer ribbon, the Data tab then Export and choose Raster.



Fill out the LAS Dataset to Raster tool as shown with a cell size of 0.25 to create a DEM raster.

DEM Raster



Geoprocessing

LAS Dataset To Raster

Parameters Environments

Input LAS Dataset
DEMLayer

Output Raster
DEM

Value Field
Elevation

Interpolation Type
Binning

Cell Assignment
Average

Void Fill Method
Linear

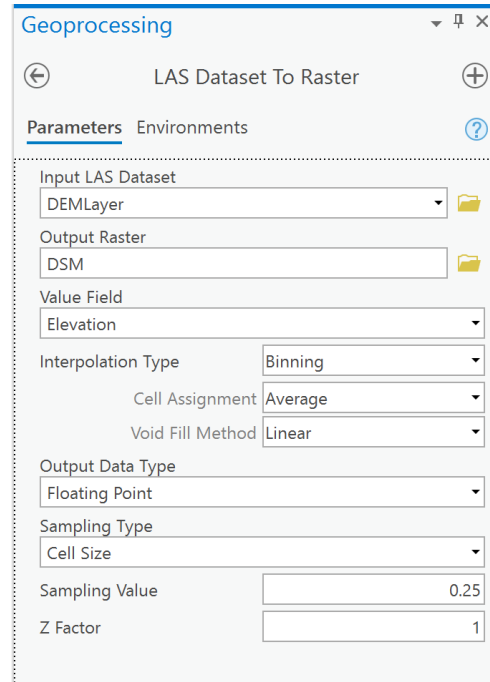
Output Data Type
Floating Point

Sampling Type
Cell Size

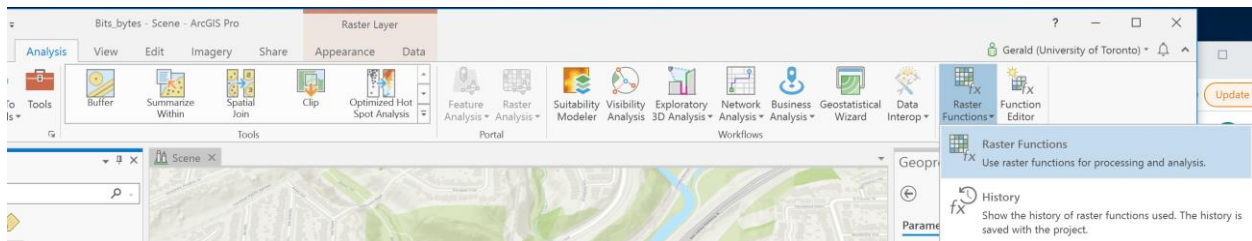
Sampling Value
.25

Z Factor
1

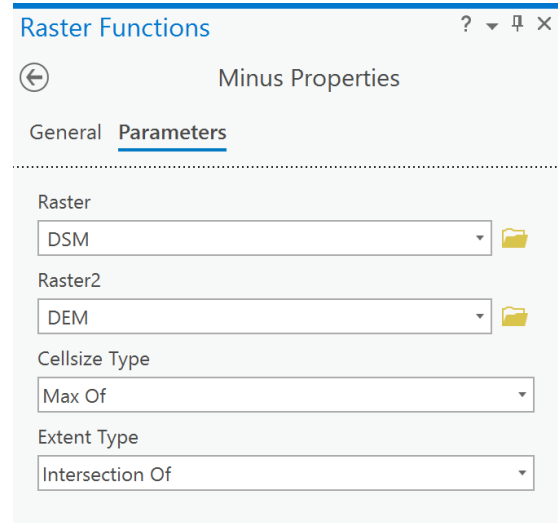
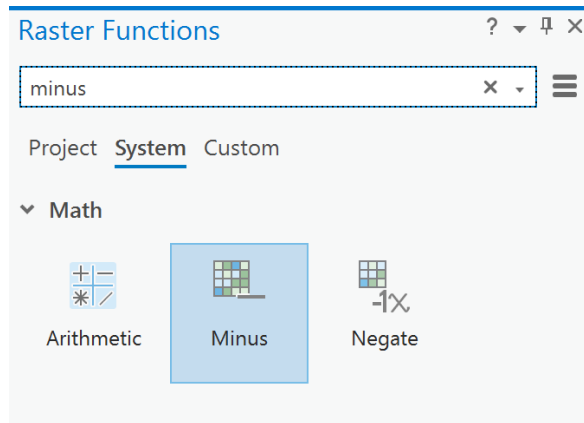
Create a DSM from the ground LAS Dataset to Raster tool.



Under the Analysis tab click on Raster Functions



Search for Minus and create a normalized DSM by subtracting the DSM by DEM. This is useful for detecting vegetation heights and building heights and identifying features on the ground. This will create a virtual raster layer.

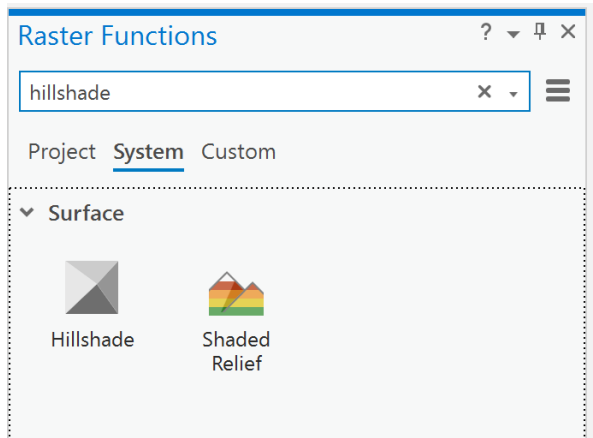


Normalized DSM, this gives height above ground of data. This will be a virtual layer.

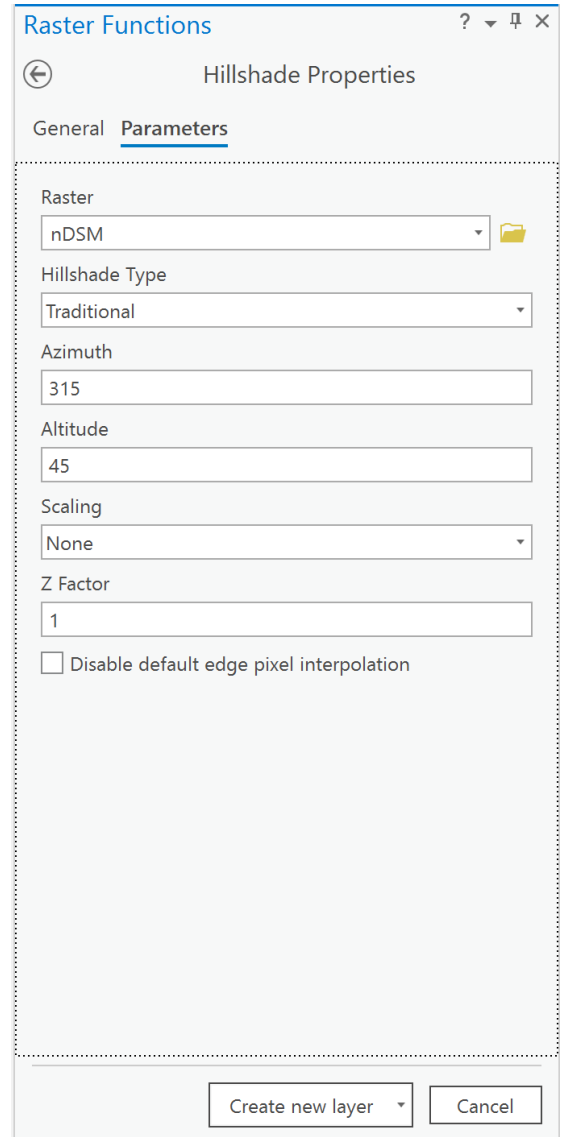


Hillshade

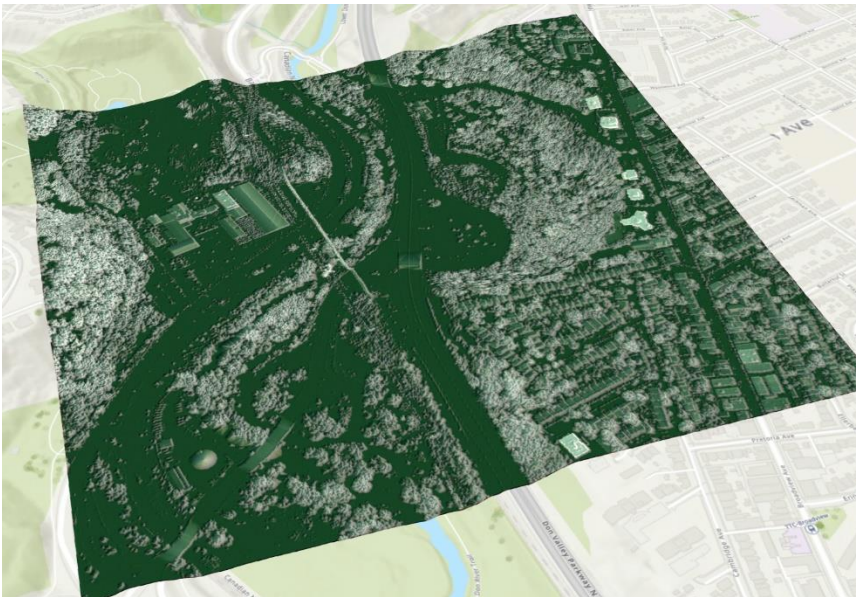
Type in Hillshade in the Raster Functions



A Hillshade layer will be created for the DEM, DSM and nDSM rasters.



The newly created nDSM hillshade. In the figure to the left the sDSM hillshade was made transparent and overlayed on top of the nDSM raster layer.



Create a hillshade for the DEM and DSM as well.



HILLSHADES

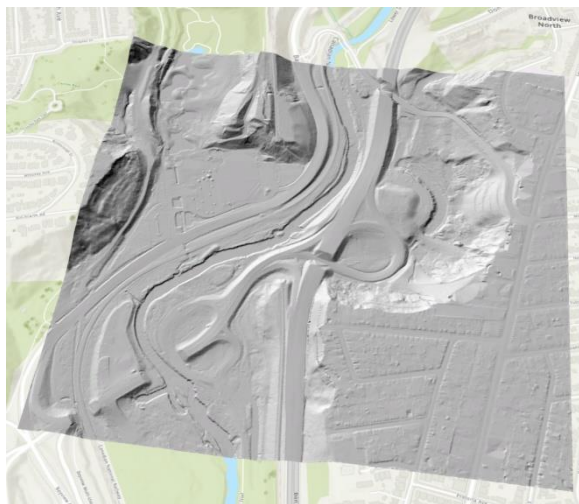
Normalized Digital Surface
Model(nDSM)



Digital Surface Model(DSM)

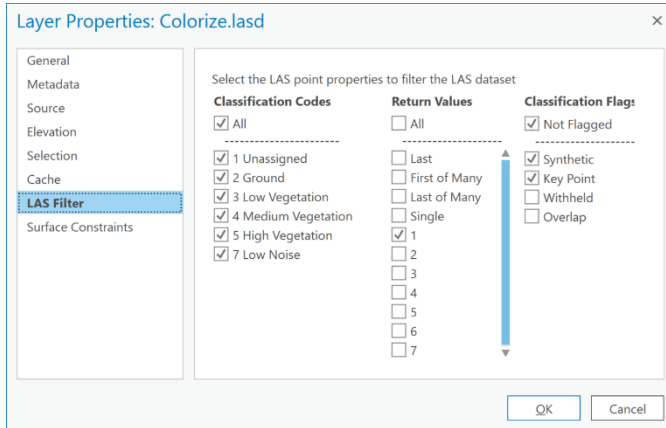


Digital Elevation Model(DEM)

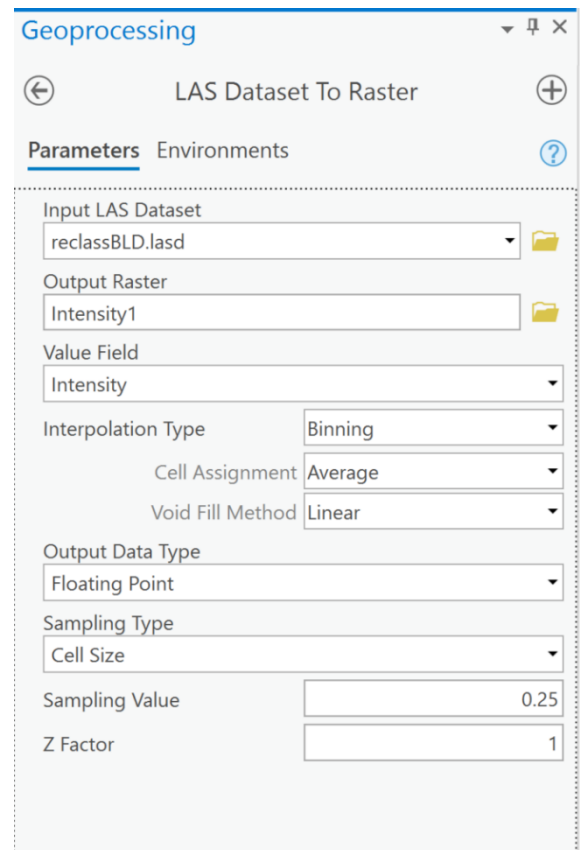


Create Intensity Image

The intensity image gives a substitute for aerial photography for the study area. It is derived from the intensity measurement which is included in this lidar dataset.



Create intensity image by converting LAS Dataset to raster



Colorize LASD

Scholars GeoPortal

Search Map (5) Download My GeoPortal ?

☒ Data ☐ Place or address

toronto orthoimagery Anywhere

☒ Downloadable content only

[Back To Downloads](#)

Download the Toronto Orthophoto from 2014. These will be used to colorize the LAS Dataset. These were found at the Scholars Geoportal <http://geo1.scholarsportal.info/>

City of Toronto Orthoimagery - 2014 - TIFF

Add - 5/9

Producer: City of Toronto Survey and Mapping Services
Date published: 2009-04-10 (publication), 2019-06-01 (publication)
Type of data layer: Raster

Permalink [http://geo.scholarsportal.info/#/details/_uri@=598628498\\$Cit](http://geo.scholarsportal.info/#/details/_uri@=598628498$Cit)

Coordinate system: 2019 - "NAD27(76) / MTM zone 10"

Abstract:

The 2014 City of Toronto orthoimagery consists of high resolution, colour images that cover the entire City of Toronto. It consists of 3797 tiles, with an image resolution of 8 cm ground pixel.

The images for this dataset were taken on April 17, June 2nd to June 23rd, and July 24 2014.



Geoprocessing

Mosaic To New Raster

Parameters Environments

Input Rasters

- NBM4.tif
- NBM1.tif
- NBL4.tif
- NBL3.tif
- NBL2.tif
- NBL1.tif
- NBG4.tif
- NBF4.tif
- NBF3.tif

Output Location

Original

Raster Dataset Name with Extension

Image.tif

Spatial Reference for Raster

NAD_1983_CSRS_UTM_Zone_17N / VCS:CGVD_

Pixel Type

8 bit unsigned

Cellsize

Number of Bands

3

Mosaic Operator

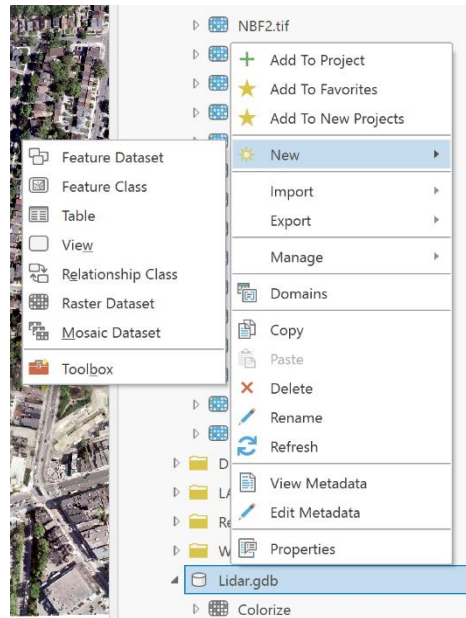
Run

Mosaic To New Raster

Saving raster, hit Esc to stop 90 %

View Details Open History

Create a geodatabase for the orthoimagery.



Mosaic the tif data into a new raster which will be output into the geodatabase.

Create a new LASD used to colorize LAS.

Colorize LAS tool.

Geoprocessing

Colorize LAS

This tool modifies the input data.

Parameters Environments

Input LAS Dataset
LidarLASD.lasd

Input Image
Image.tif

Band Assignment
LAS Channel Image Band

Red	Band_1
Green	Band_2
Blue	Band_3

Target Folder
ColourLidar

Output LAS Dataset
Colorize.lasd

LAS File Options

Output File Name Suffix
_colorized

LAS File Version
LAS 1.4 Files

Point Format
7

Compression
No Compression

☒ Rearrange Points

Geoprocessing

Create LAS Dataset

Parameters Environments

Input Files

- C:\Lidar_Bits_Bytes\Colorize\6315_48375.las
- C:\Lidar_Bits_Bytes\Colorize\6315_48380.las
- C:\Lidar_Bits_Bytes\Colorize\6320_48375.las
- C:\Lidar_Bits_Bytes\Colorize\6320_48380.las

☐ Include Subfolders

Output LAS Dataset
LidarLASD.lasd

Surface Constraints

Input Features

Height Field

Type

Coordinate System
NAD_1983_CSRS_UTM_Zone_17N / VCS:CGVD_19

Create PRJ For LAS Files
No LAS Files

☒ Compute Statistics

☐ Store Relative Paths

Use the raster image from above

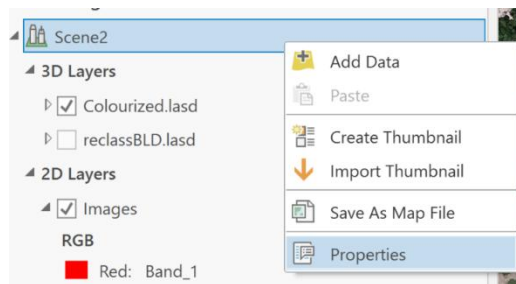


Colorized LASD view from arcgis pro

Viewing Point Cloud data in AGOL

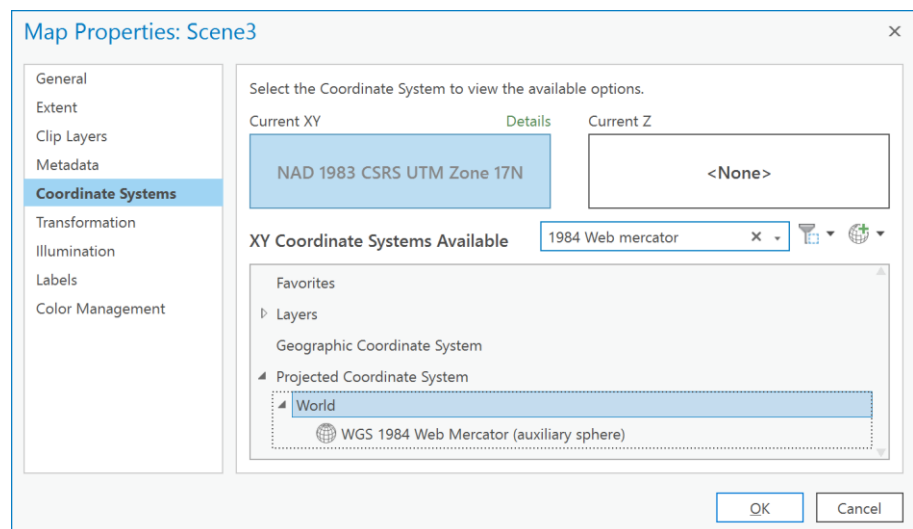
Ensure that the scene is in a Webmercator projection

Right click on the Scene and click on Properties

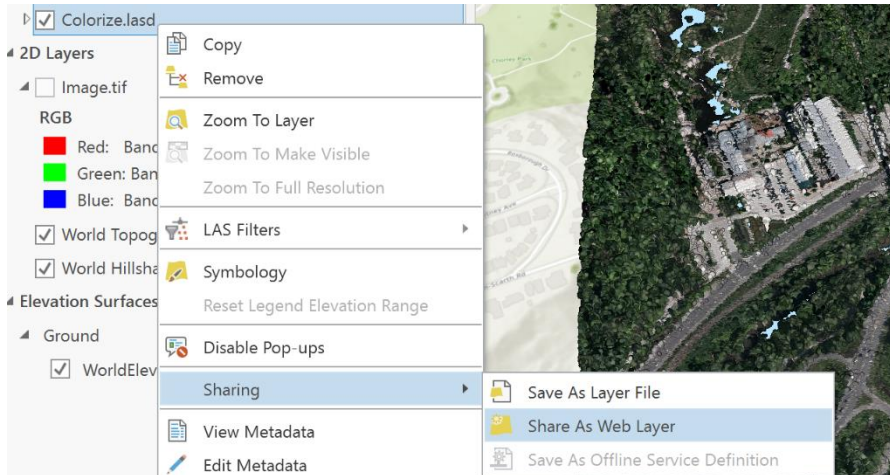


Then click on Coordinate Systems and click on Current XY

Search for 1984 Web Mercator then click on Projected Coordinate Systems, World and Choose WGS 1984 Web Mercator



Share web scene to ArcGIS Online



Fill out the Share as Web Scene dialogue.

Share As Web Layer ? ▾ ⌵ ×

Sharing selected layer as a web layer

General Configuration Content

RGB.lasd

Summary

Lidar

Tags

point cloud × Add Tag(s)

Layer Type

Scene

Location

Folder

LASD

Share with

☐ Everyone

☒ University of Toronto

Groups ▾

Finish Sharing

Analyze Publish Jobs

ArcGIS Online Scene

