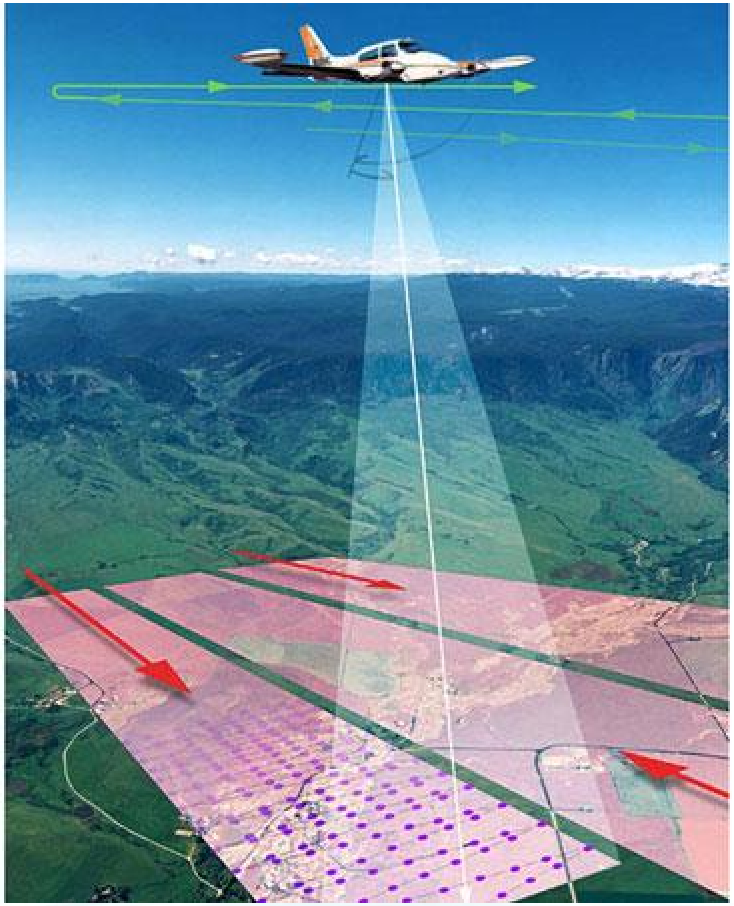
Constructing Contours from LiDAR Topographic Survey



SWFWMD Disclaimer:

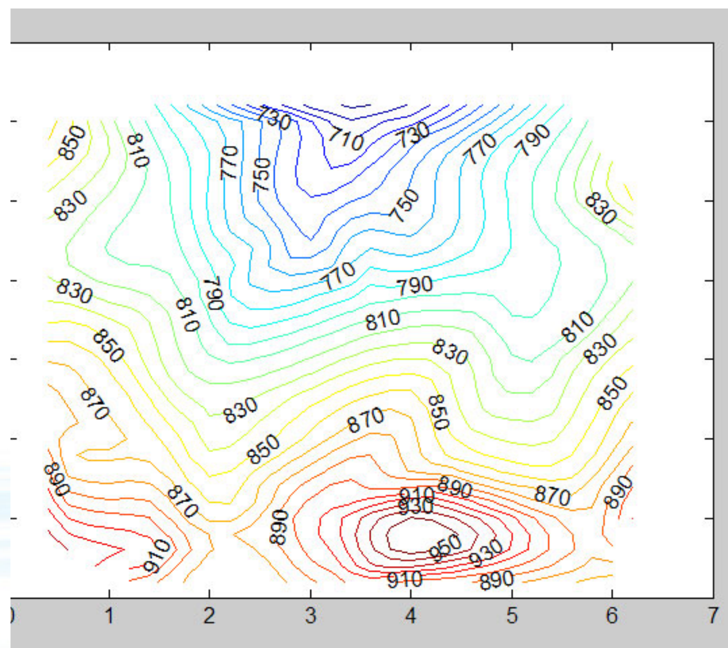
The Southwest Florida Water Management District (SWFWMD) is not endorsing or recommending any software product or manufacture in this series of Webinars. The techniques, hints, and practices presented represent business procedures used at the Southwest Florida Water Management District and were designed for internal use. Outside agencies, consultants, and GIS professionals may use different products and workflows.

As with all Geographic Information System workflows, multiple workflows may be used to accomplish similar results. The workflows presented in these Webinars represent the most common workflow used at the SWFWMD.

The District strongly recommends that all contour representations of surfaces be used for cartographic purposes and not for measurements, engineering design, or Hydrological/Hydraulic Modeling.

In the Olden Days…

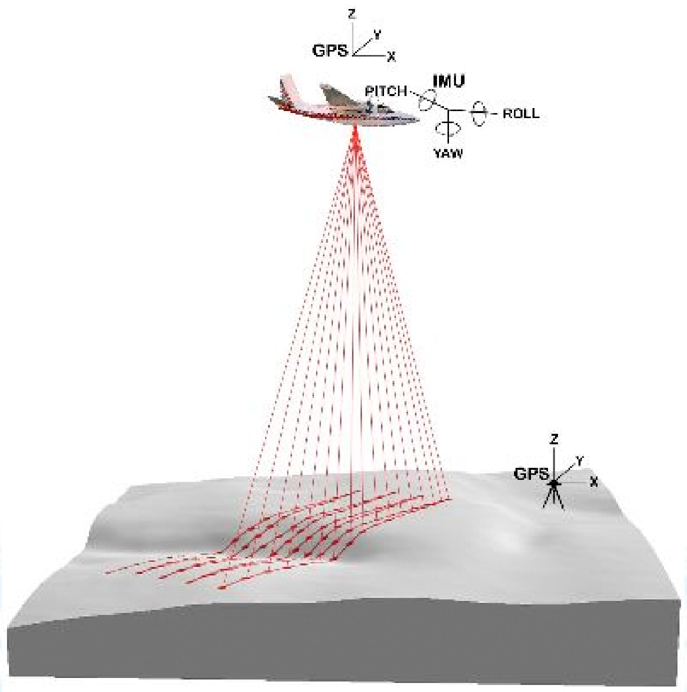
Surveyors would conduct topographic surveys by setting out a 50’ or 100’ grid, and using a Plane Table, determine elevations. Then, they would collect **“Model Key Points”,** obvious low (or high) elevations, and **breaklines**, places where the elevation changes abruptly. The **spot elevations** and breaklines would be represented as a “contour surface”



Today... we use LiDAR

Data collected during the Aerial Acquisition Phase of a LiDAR Topographic Mapping Study include:

1- Laser Points (ranging from the vehicle)
2- Global Position Satellite Data (X, Y, Z) of the vehicle
3- Inertial Momentum (pitch, roll, yaw) of the vehicle



LiDAR Data

Data collected and/or processed during the Mapping Phase of a LiDAR Topographic Mapping Study include:

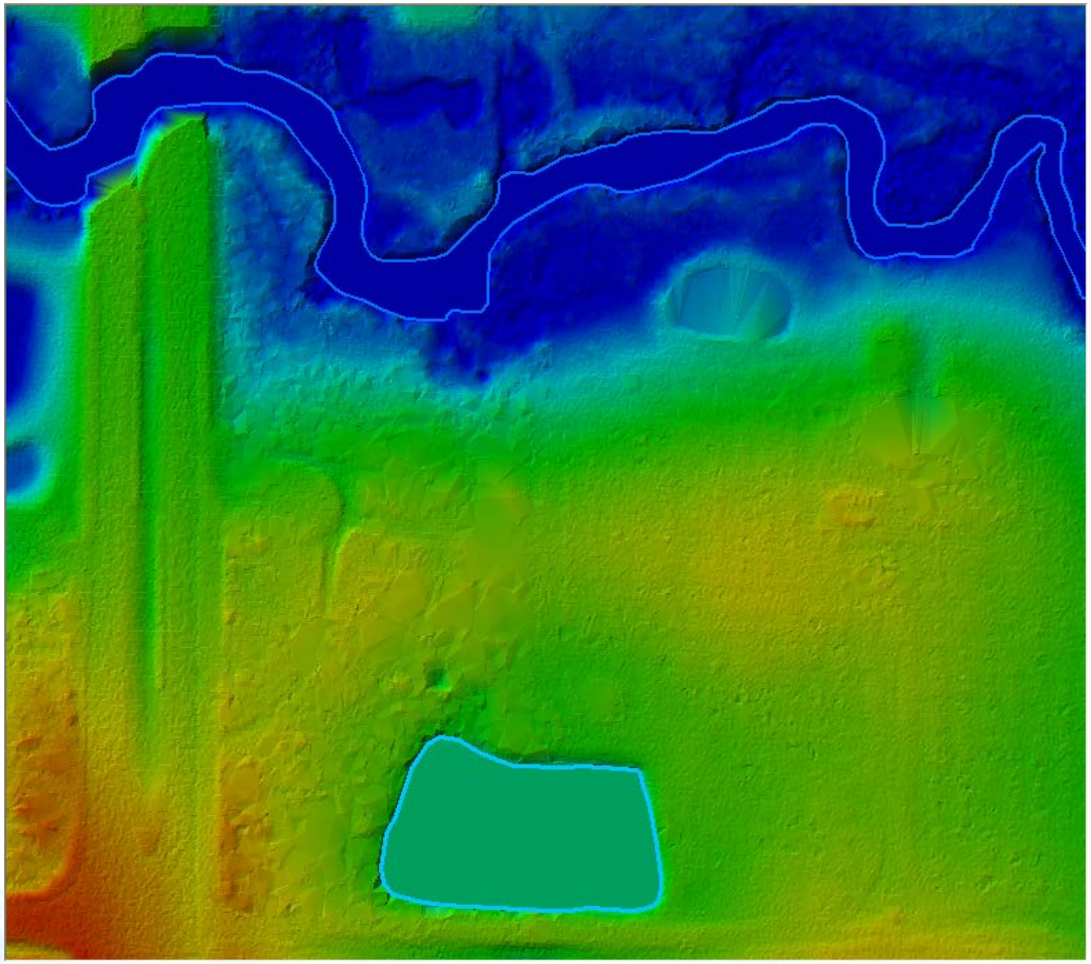
1- Laser Points in the Laser Point Cloud are classified by either automated or semi-automated methods.

2- Laser Points are tested for accuracy. Accuracy classes include,
   - Non-Vegetated Vertical Accuracy – accuracy of laser points on level, open habitats (ex. Level dirt and asphalt),
   - Vegetated Vertical Accuracy – accuracy of laser points on level surface in obscured areas (forests and wetlands), and
   - Consolidated Vertical Accuracy – the combined accuracy of laser points in all habitats.

3- Breaklines are compiled to delineate;
   - Waterbodies (and a level pool elevation)
   - Hydrological Features (top of bank and/or thalwag)
   - Obscured, abrupt surface changes.

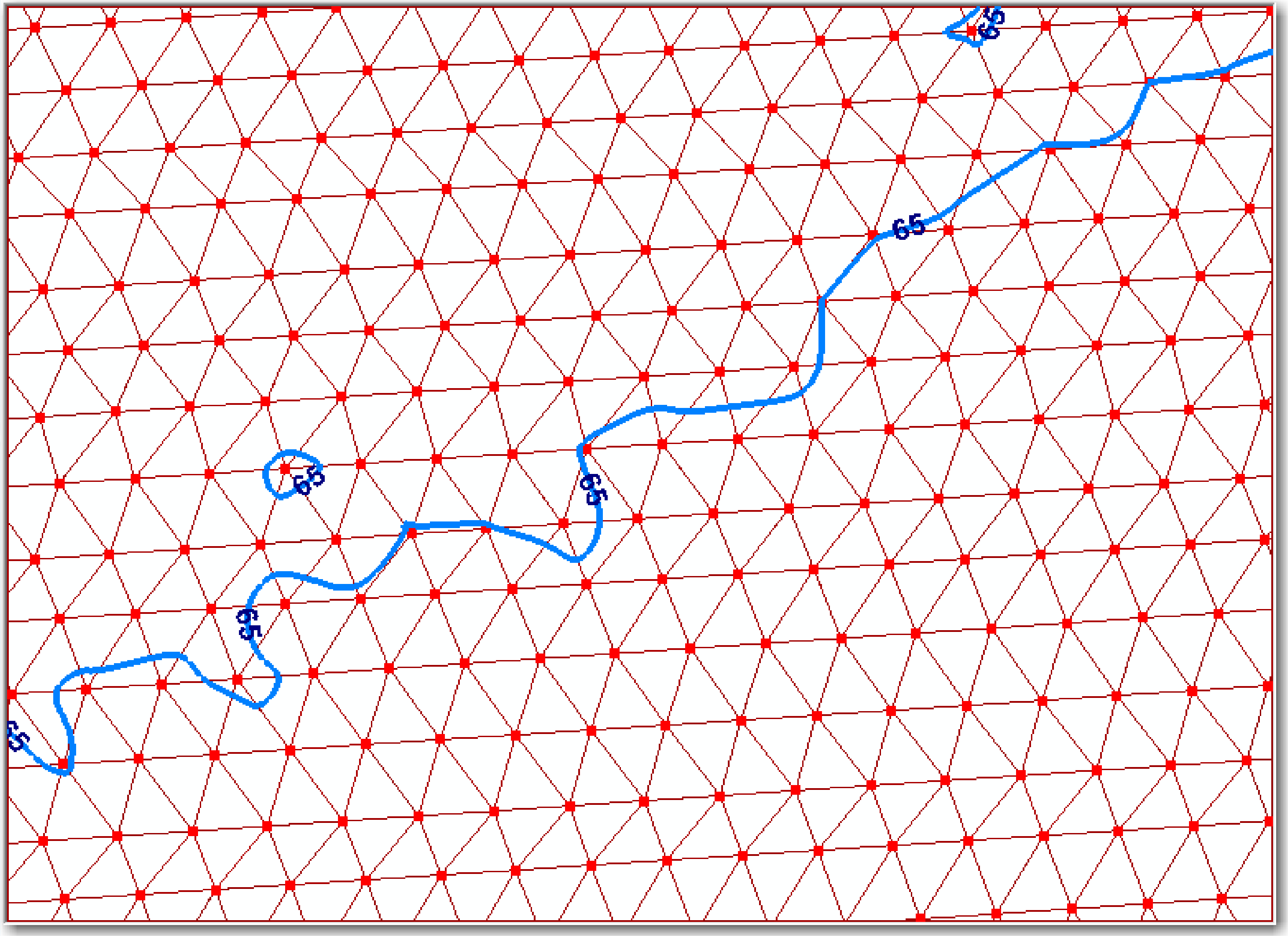
LiDAR Data Products - Derived

Laser Points and Breaklines are interpolated into a Triangular Irregular Network (TIN), the “best representation” of the surface.



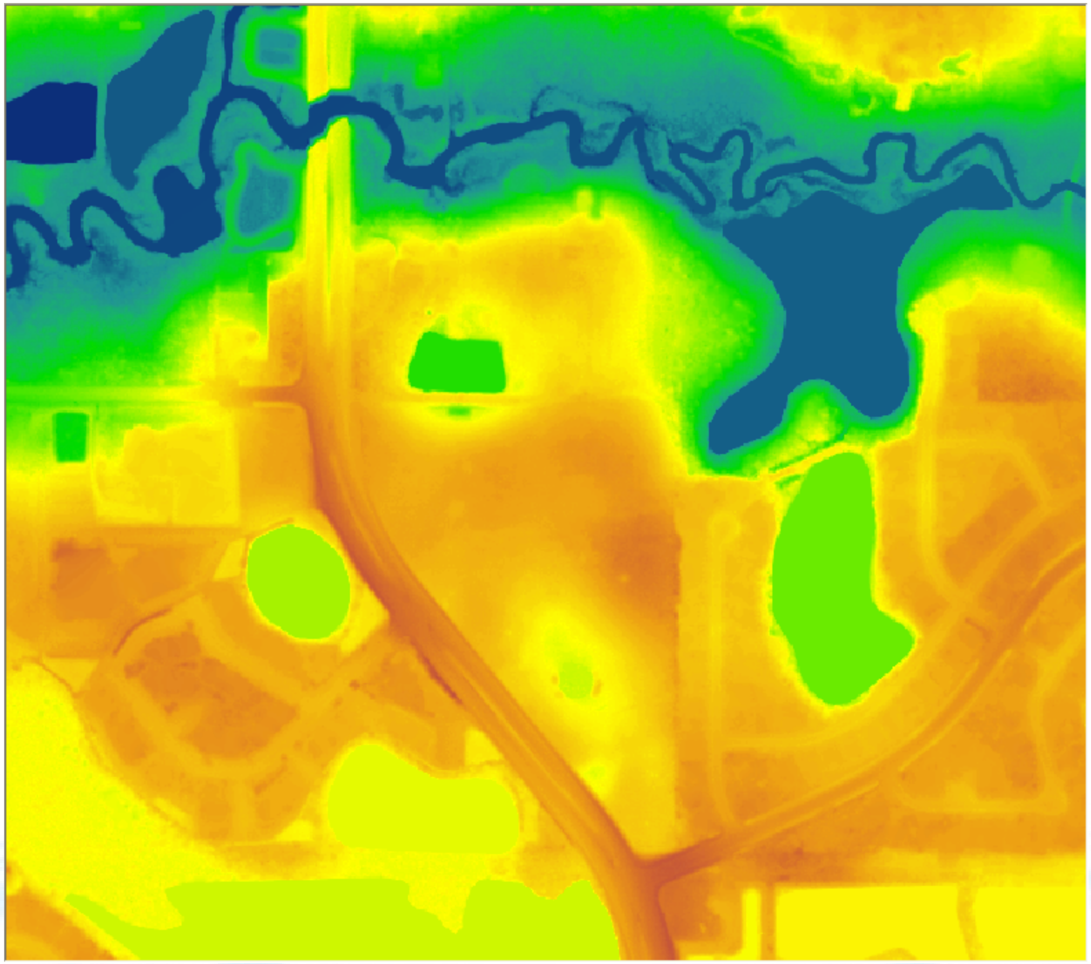
LiDAR Data Products - Derived

Contours can be derived from a TIN by Linear Interpolation



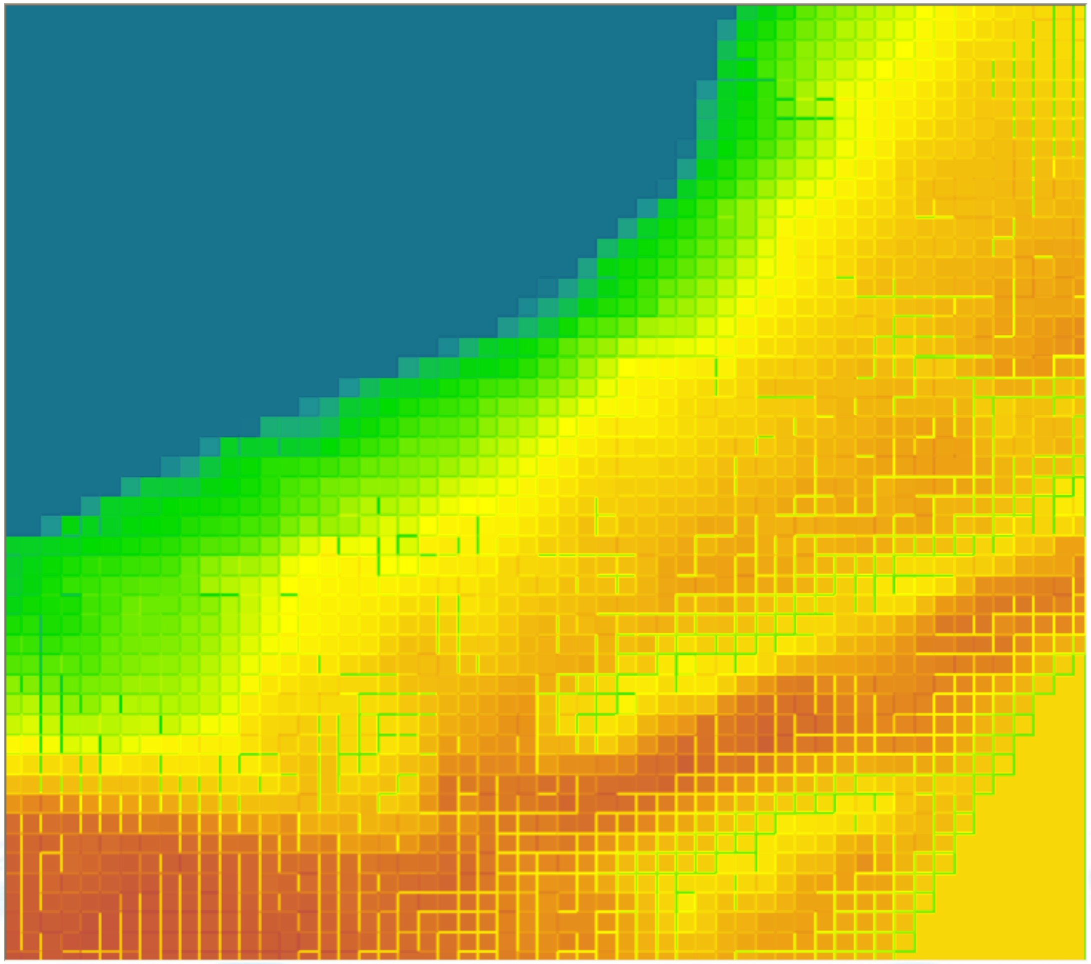
LiDAR Data Products - Derived

A Digital Elevation Model (DEM) can be interpolated from the TIN by any of several computational algorithms. The most common are (1) Nearest Neighbor (NN) and Inverse Distance Weighted (IDW). The resulting RASTER is typically used for Hydrological & Hydraulic Modeling and for contour extraction.



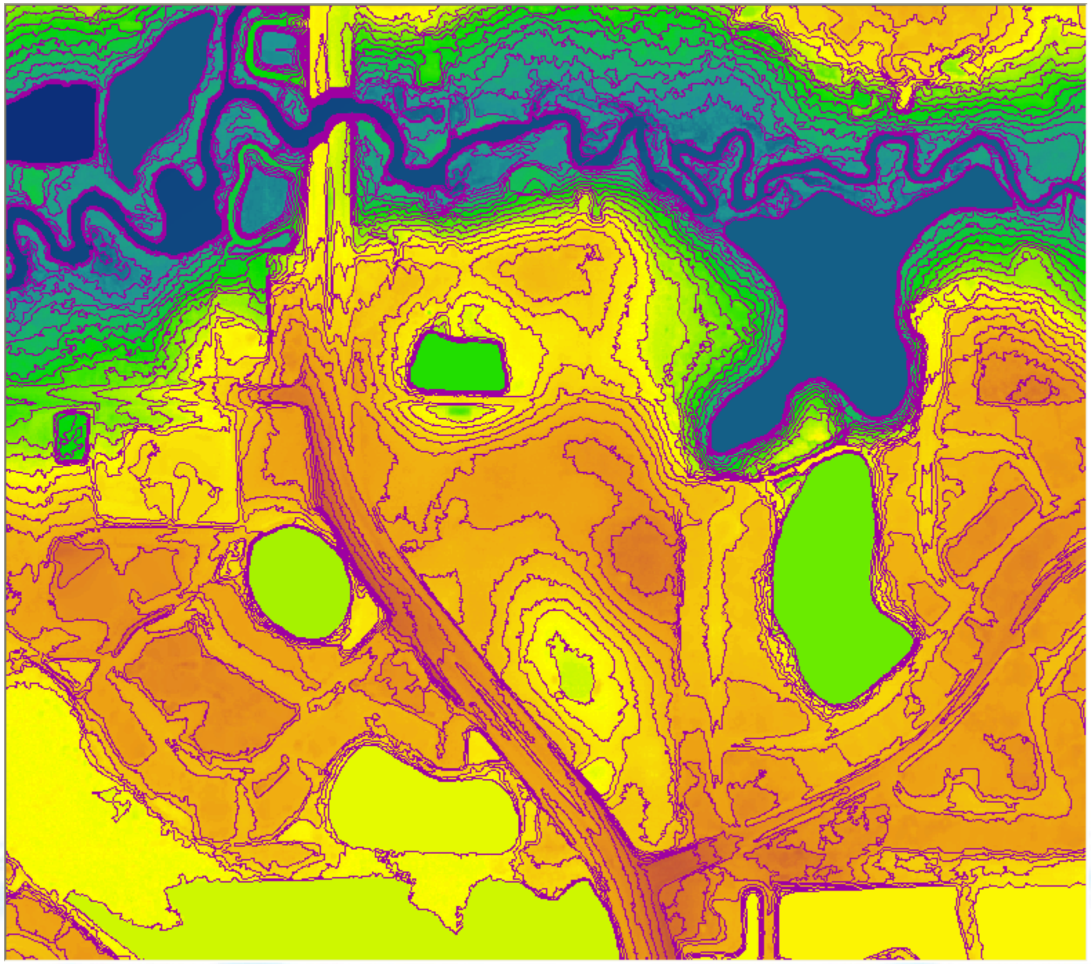
LiDAR Data Products - Derived

The DEM constructed is a 5’ x 5’ raster representation of the TIN which is the “best representation” of the surface.



LiDAR Data Products - Derived

Contours can be derived from a DEM by one of two algorithms, Level Curve Tracing or Recursive Subdivision. In either case, the contour goes through the center of the 5’ x 5’ DEM cell.



LiDAR Data Products - Derived

Because the DEM was constructed from laser points with an average density of 2 postings per square meter, there is typically “noise” in the surface which produces “ragged” contours. Because of the additional laser uncertainty in wetland areas, contours in wetlands include additional “noise”

LiDAR Data Products - Derived

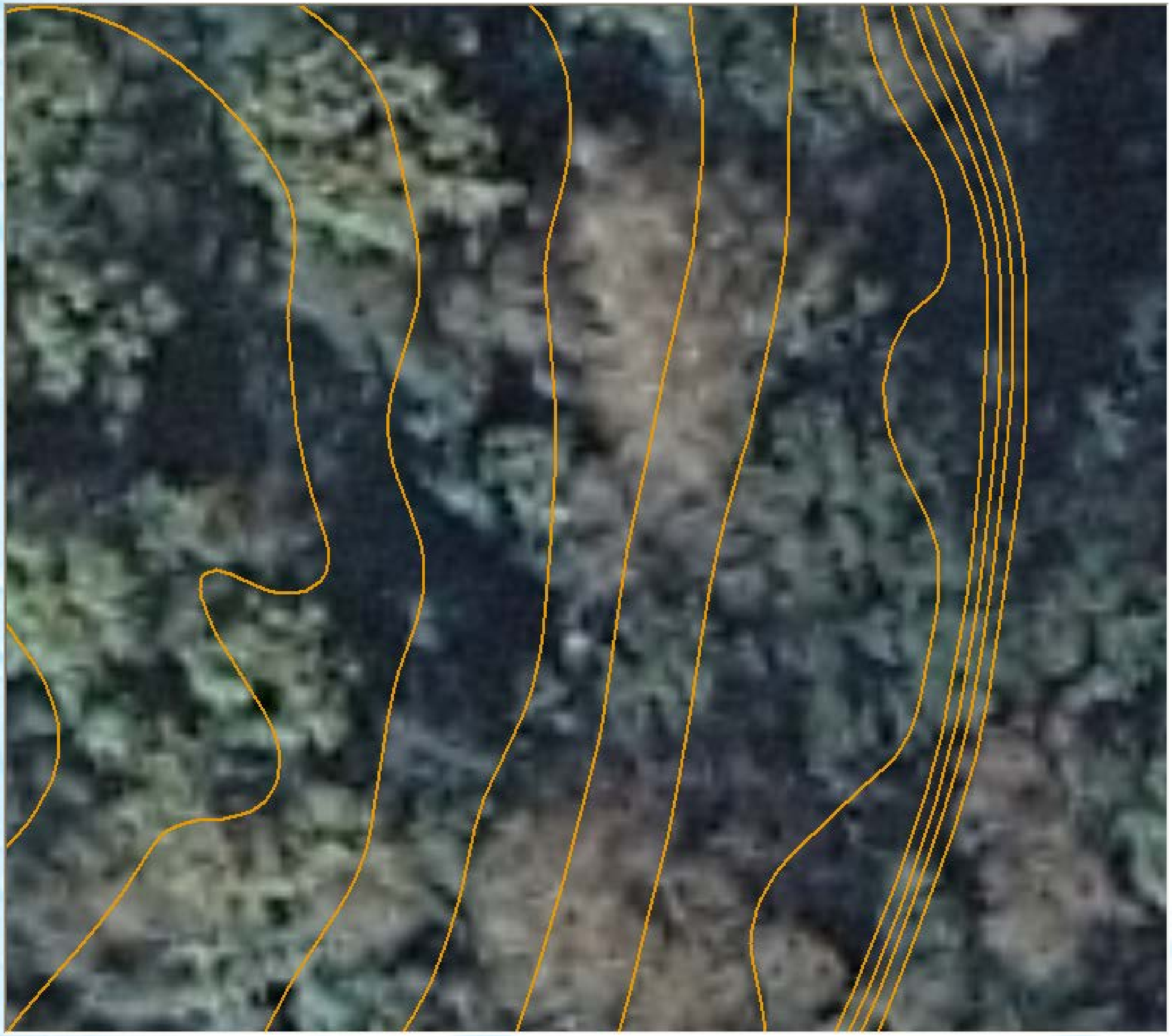
Three basic methods for “smoothing” contours,

1- Key and Model (breakline) Points – this method removes ground laser points and retains only points that are greater than a pre-determined elevational difference from each other. A DEM is regenerated from the decimated surface and contours are extracted,

2- The DEM surface is statistically smoothed using zonal statistical analysis. Cells that have similar elevations (at a predetermined threshold) are averaged together and a new DEM generated for contour extraction, and

3- A linear smoothing algorithm, usually the method defined by David Douglas and Thomas Peucker (1973), is used because it reduces the number of points along curves but retains the underlying linear geometry.

LiDAR Data Products - Derived



Yellow = Original
Orange = Smoothed

GIS Methods for Contour Generation – Using LP360

1- The preferred (and easiest) method for contour generation is to load the LiDAR data (tiles) into ArcGIS through the LP360 extension, and then load appropriate Breaklines (HydrologicFeatures, Islands, and Waterbodies) into the ArcMap document.

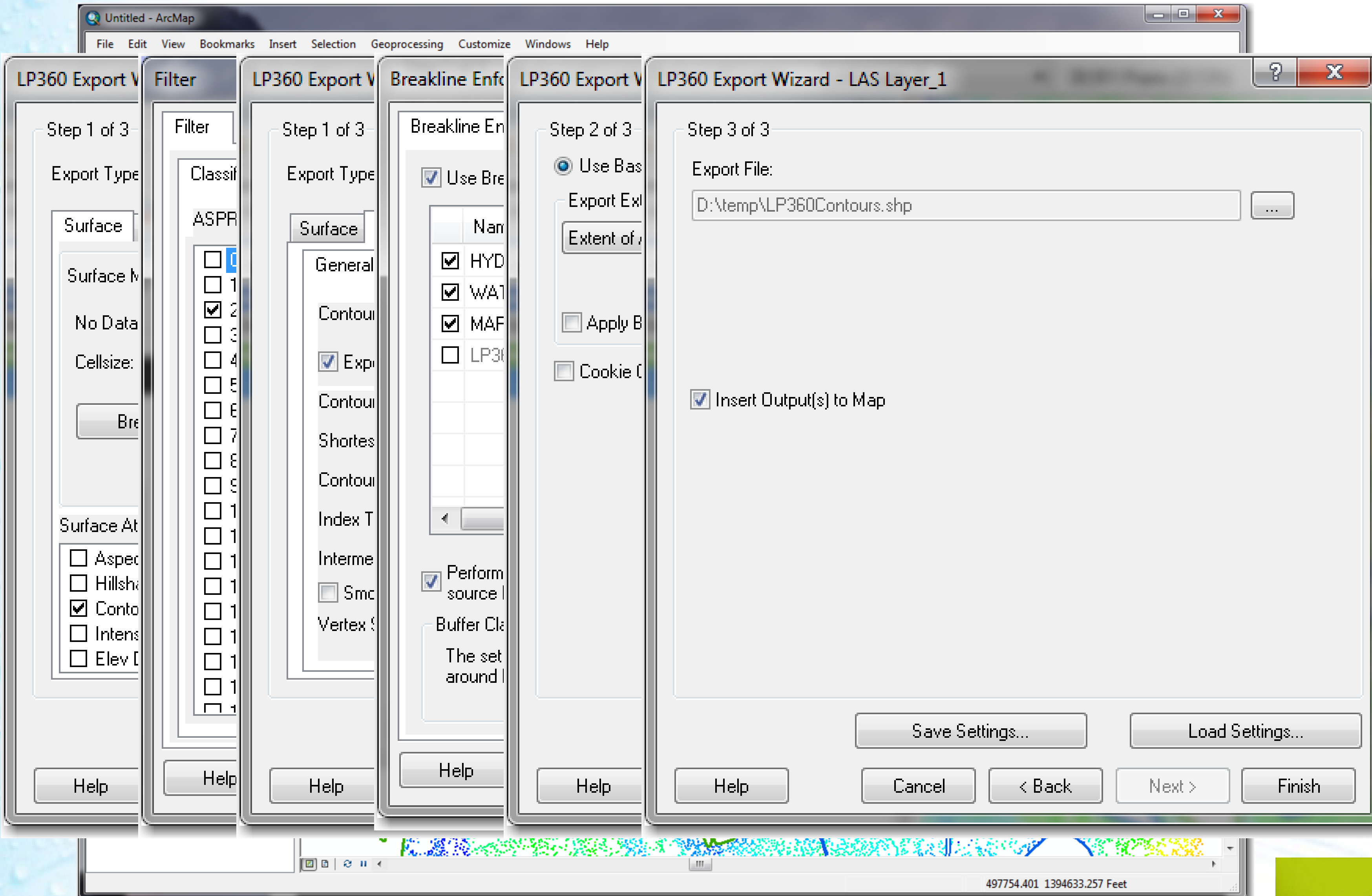
Using the LP360 contour generator, set the parameters to:

1- enforce the breaklines
2- construct 1’ contours, with
3- the minimum contour length to 200’ and
4- export the results to a shapefile.

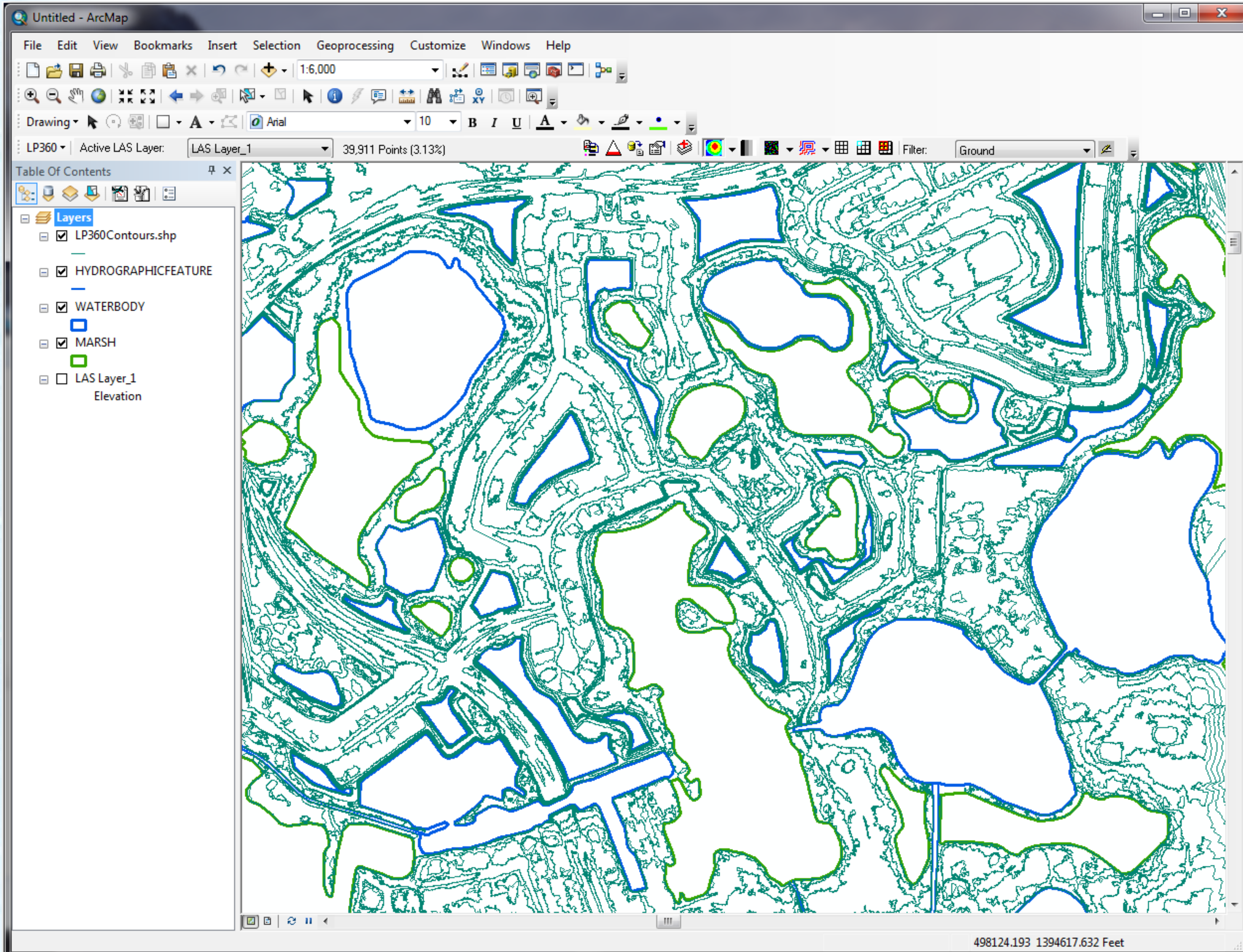
Remember to:

- Use only the Ground Class (Class 2)
- Set the Cell Size to 5.0’ (or less)
- Check the “Contour” option in the Surface Attribute(s) to Extract tab
- Include the “On-the-Fly” Topology Checker

GIS Methods for Contour Generation – Using LP360



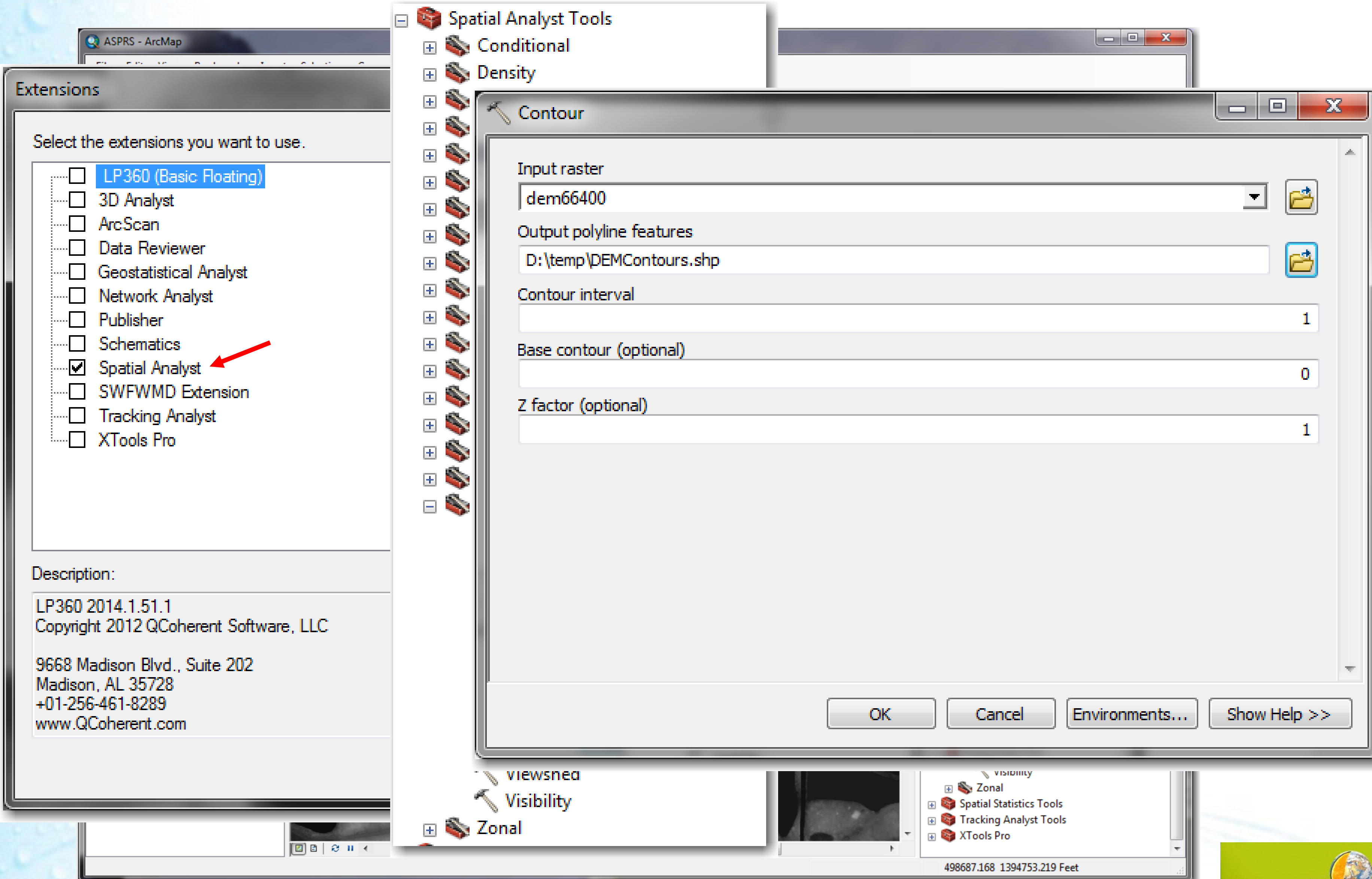
GIS Methods for Contour Generation – Using LP360



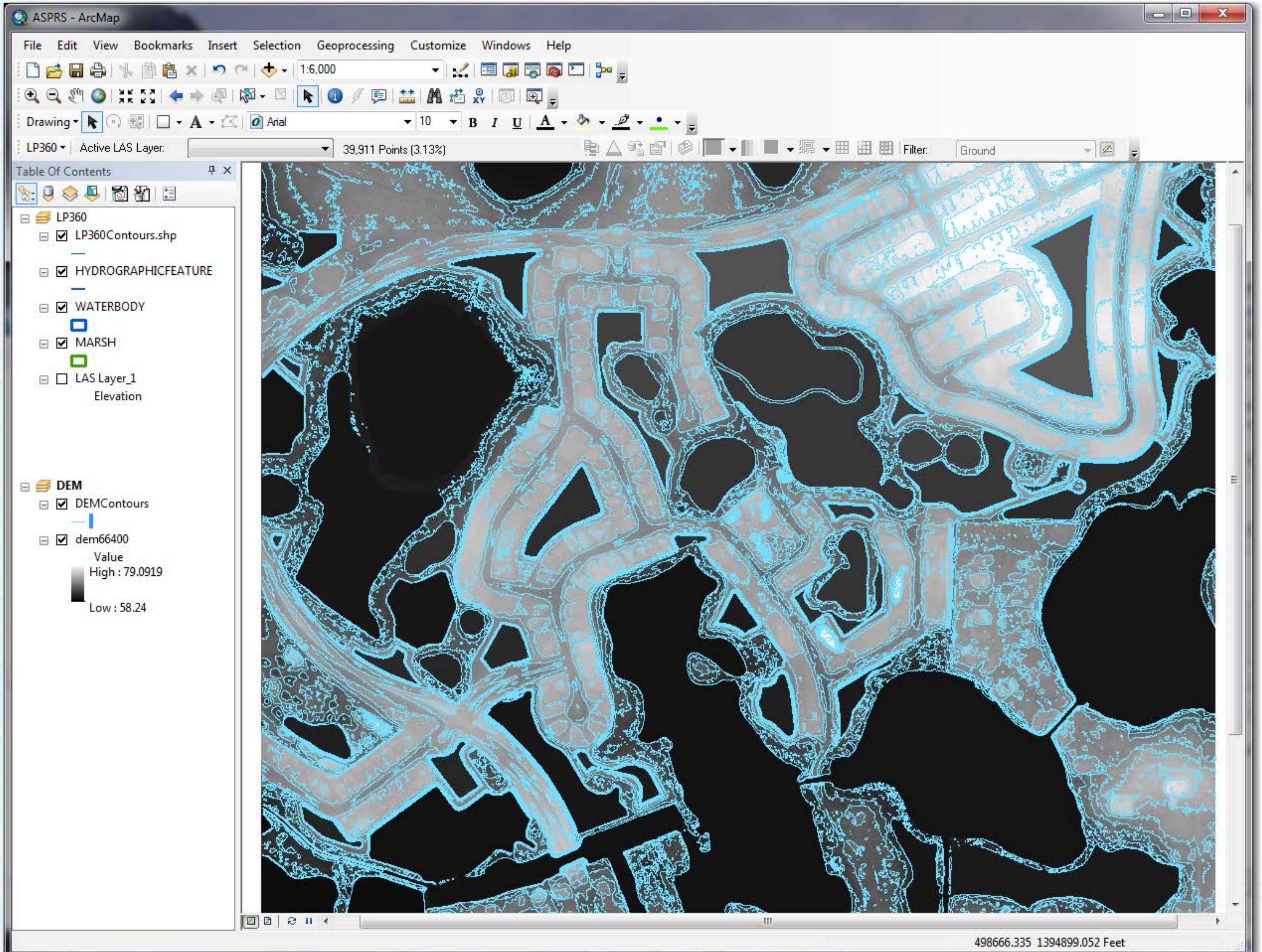
GIS Methods for Contour Generation – Using ArcGIS

2- The easiest method for generating contours using ArcGIS requires the use of a rasterized Digital Elevation Model. Starting with a LP360-derived DEM and with the Spatial Analyst extension activated,

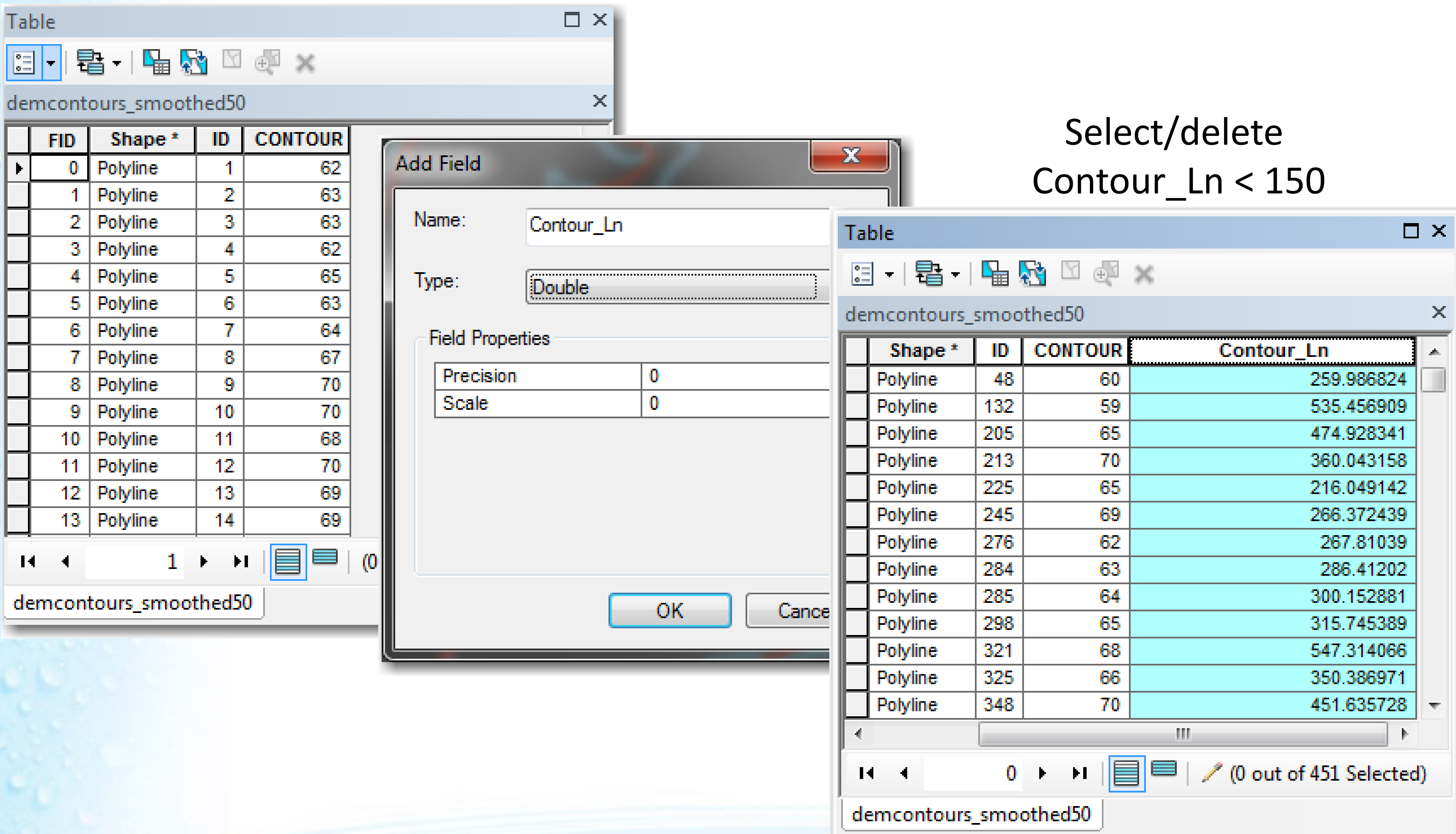
GIS Methods for Contour Generation – Using ArcGIS



GIS Methods for Contour Generation – Using ArcGIS



GIS Methods for Contour Generation – Contour Reduction (ArcGIS)

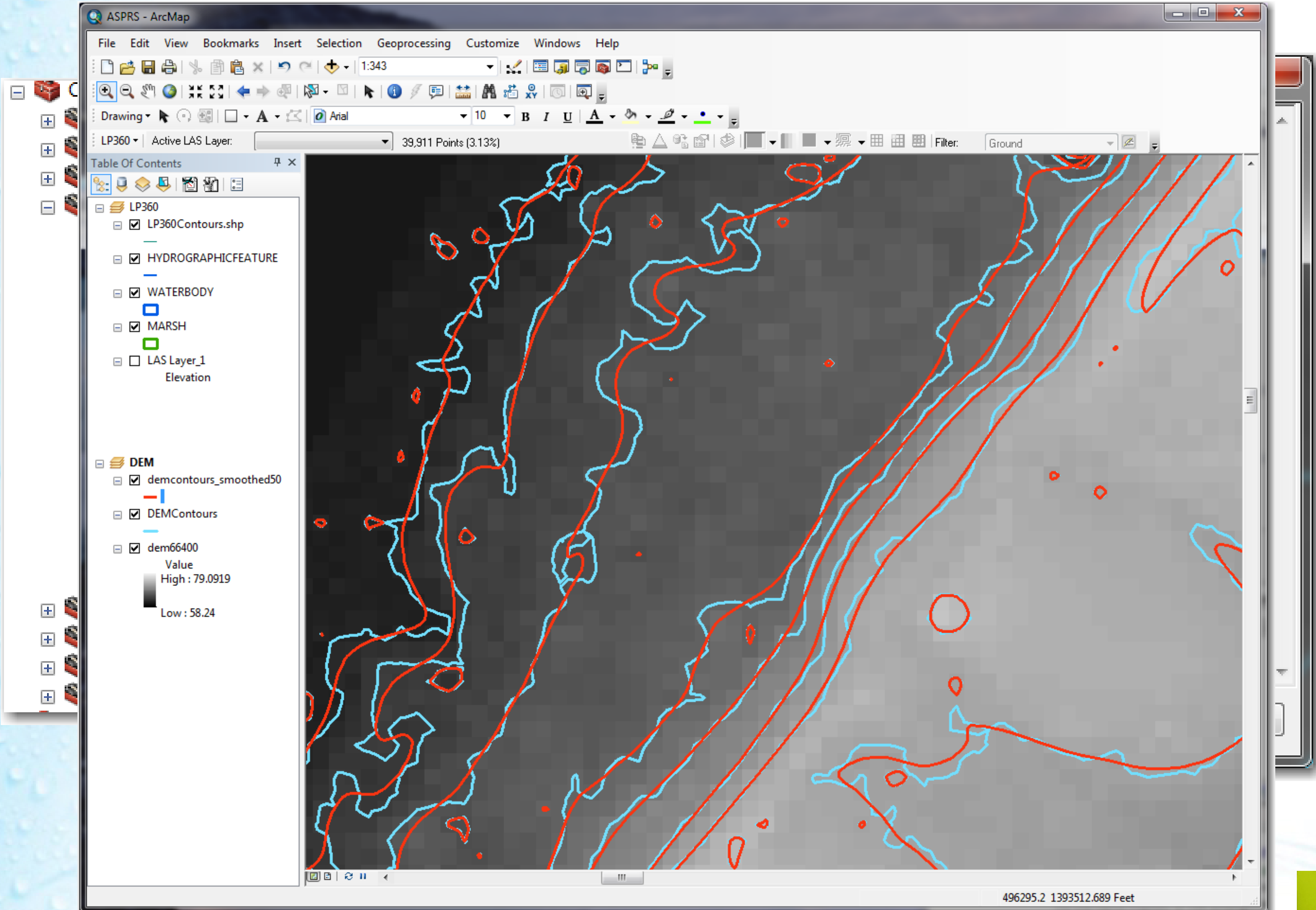


FID	Shape *	ID	CONTOUR
0	Polyline	1	62
1	Polyline	2	63
2	Polyline	3	63
3	Polyline	4	62
4	Polyline	5	65
5	Polyline	6	63
6	Polyline	7	64
7	Polyline	8	67
8	Polyline	9	70
9	Polyline	10	70
10	Polyline	11	68
11	Polyline	12	70
12	Polyline	13	69
13	Polyline	14	69

Select/delete
Contour_Ln < 150

Shape *	ID	CONTOUR	Contour_Ln
Polyline	48	60	259.986824
Polyline	132	59	535.456909
Polyline	205	65	474.928341
Polyline	213	70	360.043158
Polyline	225	65	216.049142
Polyline	245	69	266.372439
Polyline	276	62	267.81039
Polyline	284	63	286.41202
Polyline	285	64	300.152881
Polyline	298	65	315.745389
Polyline	321	68	547.314066
Polyline	325	66	350.386971
Polyline	348	70	451.635728

GIS Methods for Contour Generation – Smoothing



Finally, select/delete contours < 150'

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