# *DPH-9.1 USGS Swath Separation Image*

## Image creation:

a. All returns shall be used to create the images.
b. All point classes and flags shall be enabled when creating the images and points flagged as withheld or classified as noise shall be excluded.
c. Elevation values and differences shall not be subjected to a threshold or otherwise clipped so all differences are represented.
d. The images will be derived from TINs to reduce the number of false difference values on slopes; however, other algorithms are acceptable.
e. The images shall consist of a 50 percent transparent RGB layer overlaying the lidar intensity image.
f. The images shall use at least three color levels wherever two or more swaths overlap within a pixel.
g. Where two or more swaths overlap within a pixel (based on point source ID),
    i. pixel color shall be based on vertical difference of swaths using the following breaks (based on multiples of the Swath Overlap Difference for the QL):
        1. 0-8 cm: GREEN;
        2. 8-16 cm: YELLOW;
        3. > 16 cm or > last additional color ramp bin value: RED (for example, addition of ORANGE pixels for the range of 16-24 cm would require red pixels to represent > 24 cm).
    ii. color choice of green, yellow, and red is suggested but not required.
    iii. no pixel shall remain uncolored (transparent) in the overlap areas.
h. Where swaths do not overlap, pixel values shall be intensity alone.

## Image file formats and version control:

a. Swath difference image format may be delivered as GeoTIFF or JPEG (with world file) by tile or as a single compressed JPEG 2000 (JP2) image mosaic.
b. The point cloud geometry and intensity data delivered shall be identical to the point cloud geometry and intensity data used to create the difference images. Changes in the point cloud geometry or intensity requires recreation of the difference images.

## Spatial extent and coordinate reference system:

a. Spatial resolution (pixel dimension) of the images shall be between 2 and 4 times the Nominal Pulse Spacing (2-4 x NPS) in the project's linear unit (meters or feet).
b. The difference images must be representative of the associated data delivery.
c. The images shall be in the same CRS as the point cloud data to ensure alignment with the point cloud.

## Description of the process that generates the Swath Separation Image:

a. Areas of swath overlap are determined within each delivery tile.
b. A Grid is created for each overlap area. Grid cell sizes are 3x the aggregate nominal pulse spacing (ANPS) as shown in Table 1 of the USGS Lidar Base Specification v 2.1. ANPS varies depending on the Quality Level of the data. The grid cells are then populated with the maximum vertical separation values of the underlying points. Points flagged as Withheld, including those points classed as High or Low Noise, are excluded from this analysis.
c. No vertical separation cut-off is used for this raster.
d. The tiled rasters are mosaicked into a single project-wide swath separation raster, with the grid cells colored based on the separation values. For QL1 and QL2, a green cell indicates an elevation difference of 8 cm or less, yellow indicates greater than 8 cm but LTE 16 cm, orange indicates greater than 16 cm but LTE 24 cm, and red is any value greater than 24 cm. The mosaicked raster graphic is found on the following page, and tiled GeoTIFFs of the complete project can be found in the output folder for this test.