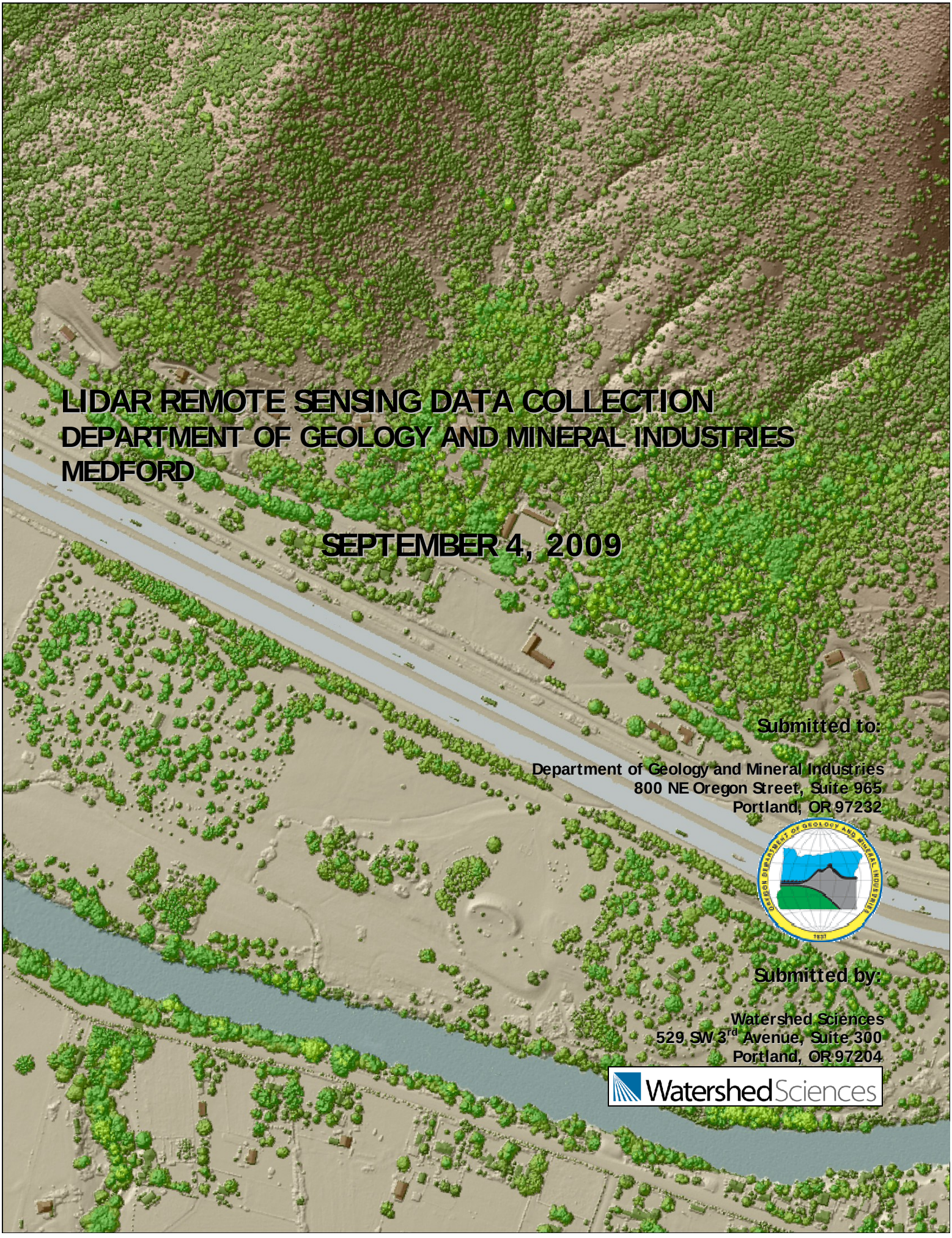


LIDAR REMOTE SENSING DATA COLLECTION
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
MEDFORD

SEPTEMBER 4, 2009

Submitted to:

Department of Geology and Mineral Industries
800 NE Oregon Street, Suite 965
Portland, OR 97232

Submitted by:

Watershed Sciences
529 SW 3rd Avenue, Suite 300
Portland, OR 97204

Watershed Sciences

LiDAR Remote Sensing Data Collection:
DOGAMI, Medford Study Area

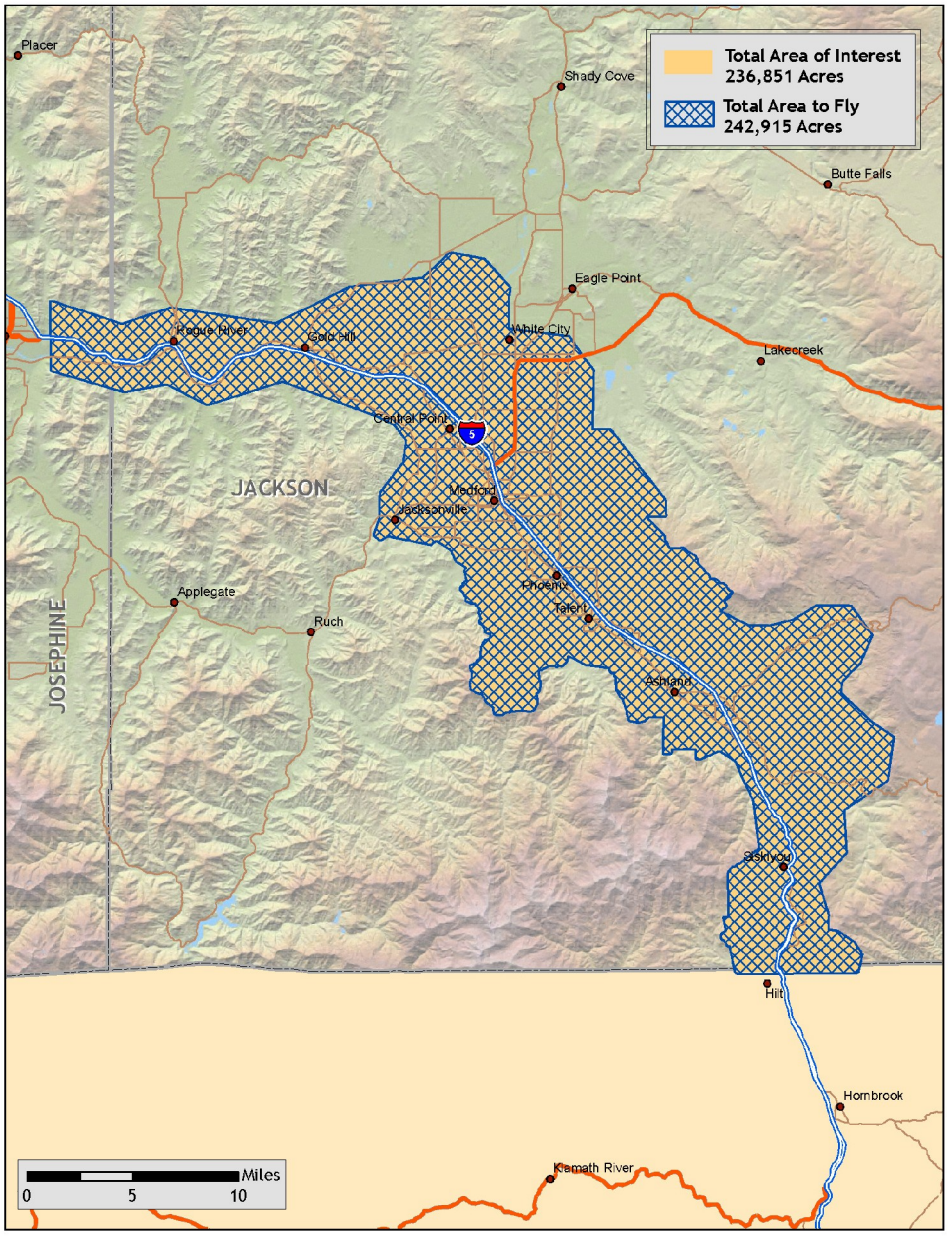
TABLE OF CONTENTS

1. Overview

1.1 Study Area (Medford)

Watershed Sciences, Inc. has collected Light Detection and Ranging (LiDAR) data of the Medford Study Area for the Oregon Department of Geology and Mineral Industries (DOGAMI). The complete area of interest (AOI) totals 370 square miles (236,851 acres) and the total area to fly (TAF) covers 380 square miles (242,915 acres). The TAF acreage is greater than the original AOI acreage due to buffering and flight planning optimization (**Figure 1.1** below). DOGAMI data are *delivered* in OGIC(HARN): Projection: Oregon Statewide Lambert Conformal Conic; horizontal and vertical datums: NAD83 (HARN)/NAVD88(Geoid03); Units: International Feet.

Figure 1.1. *DOGAMI Medford Study Area.*

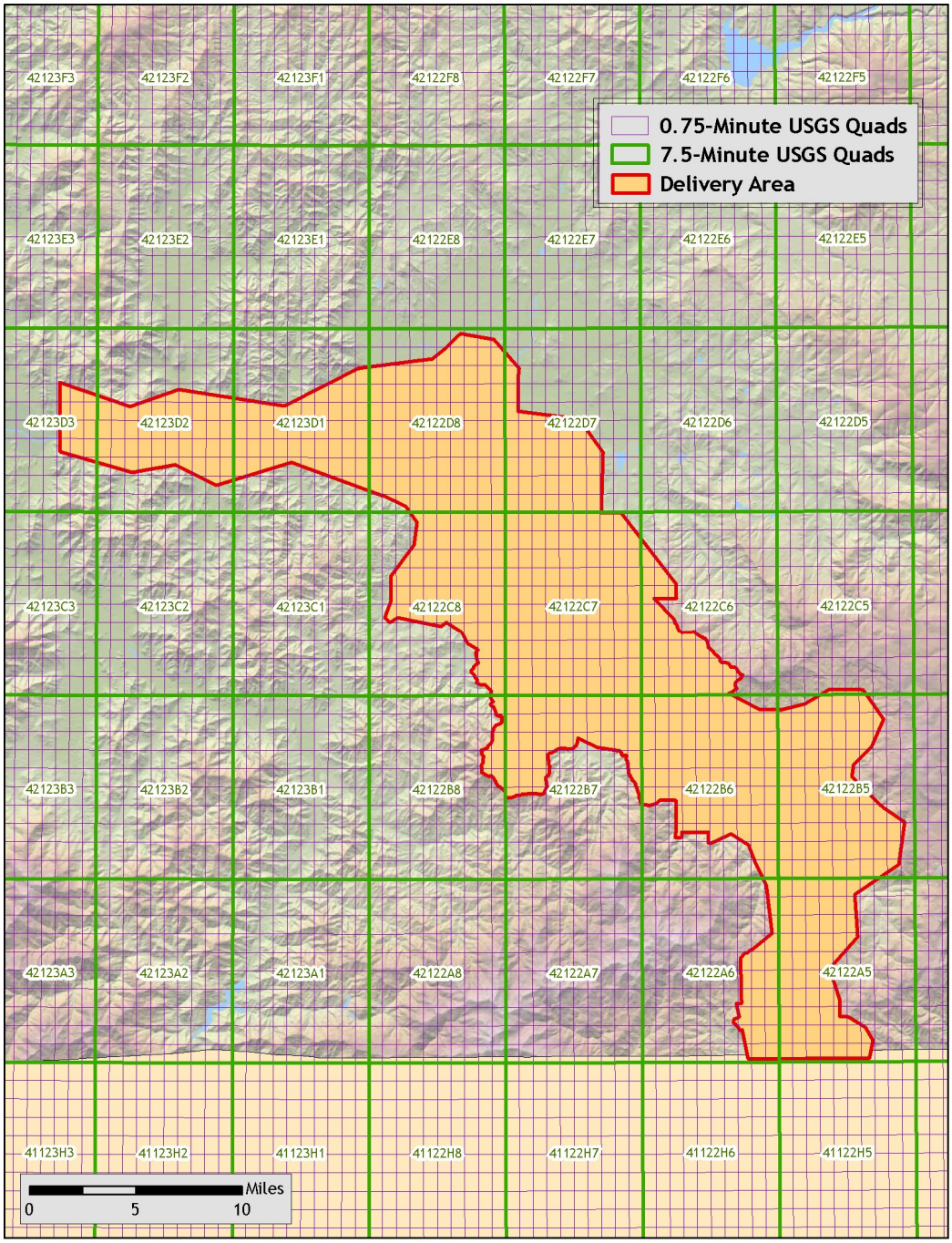


1.2 Area Delivered to Date

Total delivered acreage to date is detailed below.

DOGAMI Medford Study Area				
	Delivery Date	**Acquisition Date**	**AOI Acres**	**TAF Acres**
Total Acres	September 4, 2009	Apr. 29, 2009 – May 12, 2009	236,851	242,915

Figure 1.2. *Medford Study Area, illustrating the delivered 0.75 and 7.5 minute USGS quads.*



1.3 Acquisition and Ground Survey

LiDAR acquisition for the Medford Study Area occurred from April 29, 2009 – May 12, 2009

Figure 1.3. Actual flightlines for the Medford Study Area illustrating the dates flown (based on GPS week).

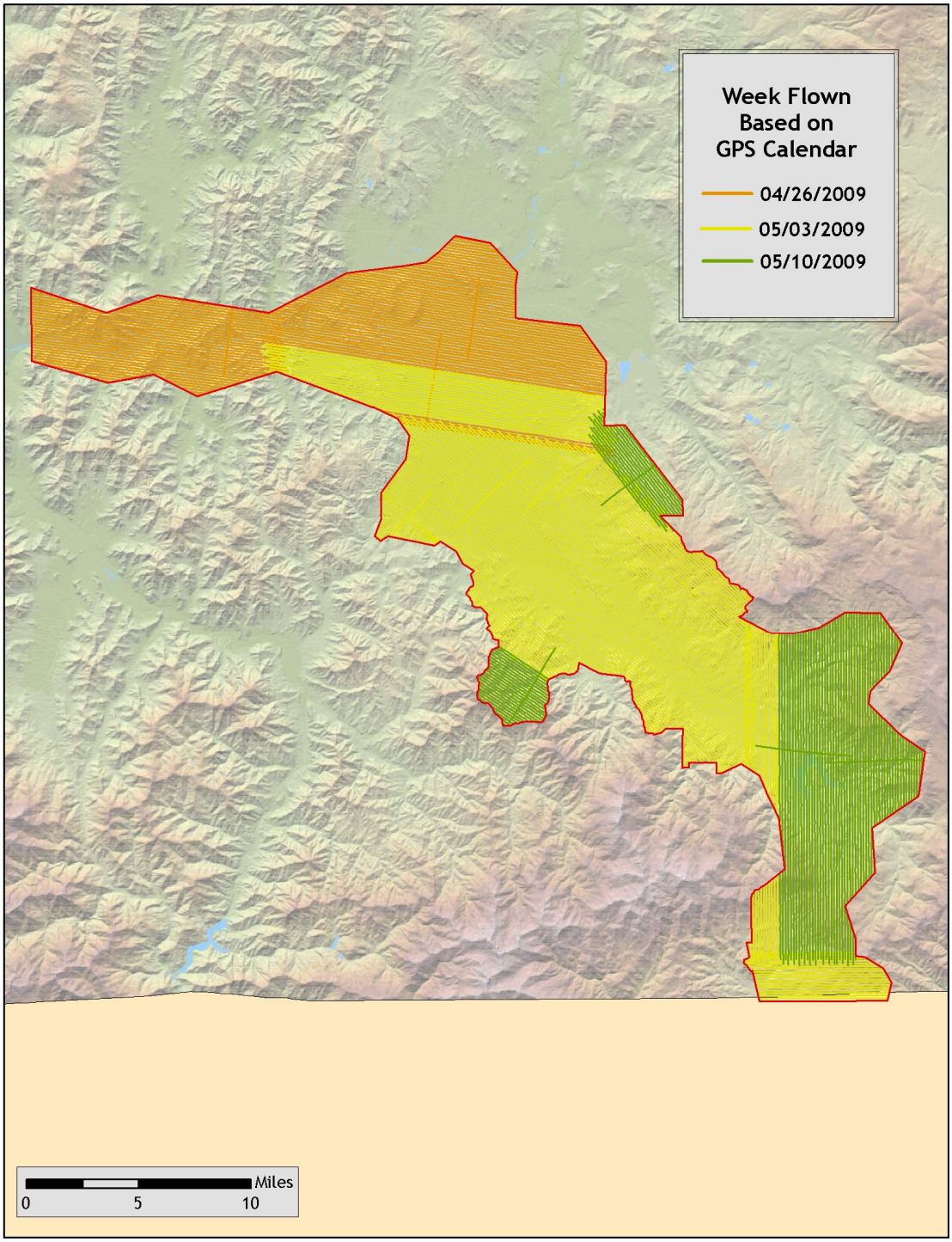
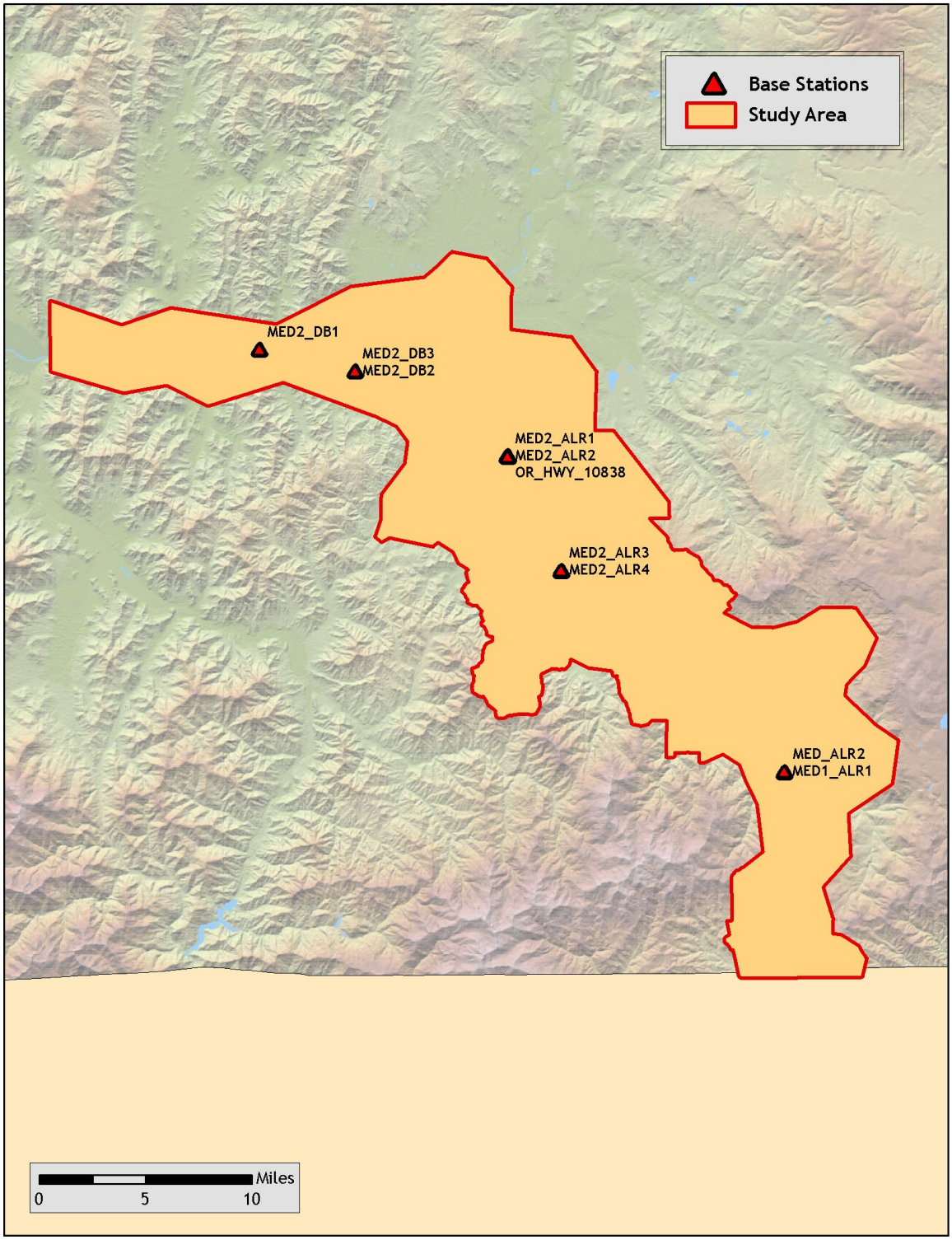


Figure 1.4. *Base stations for the Medford Study Area.*



For the Medford Study Area, 2,661 RTK points were collected. Figure 1.5 shows a detailed view of selected RTK locations.

Figure 1.5. RTK point locations for the Medford Study Area; images are NAIP orthoimages.

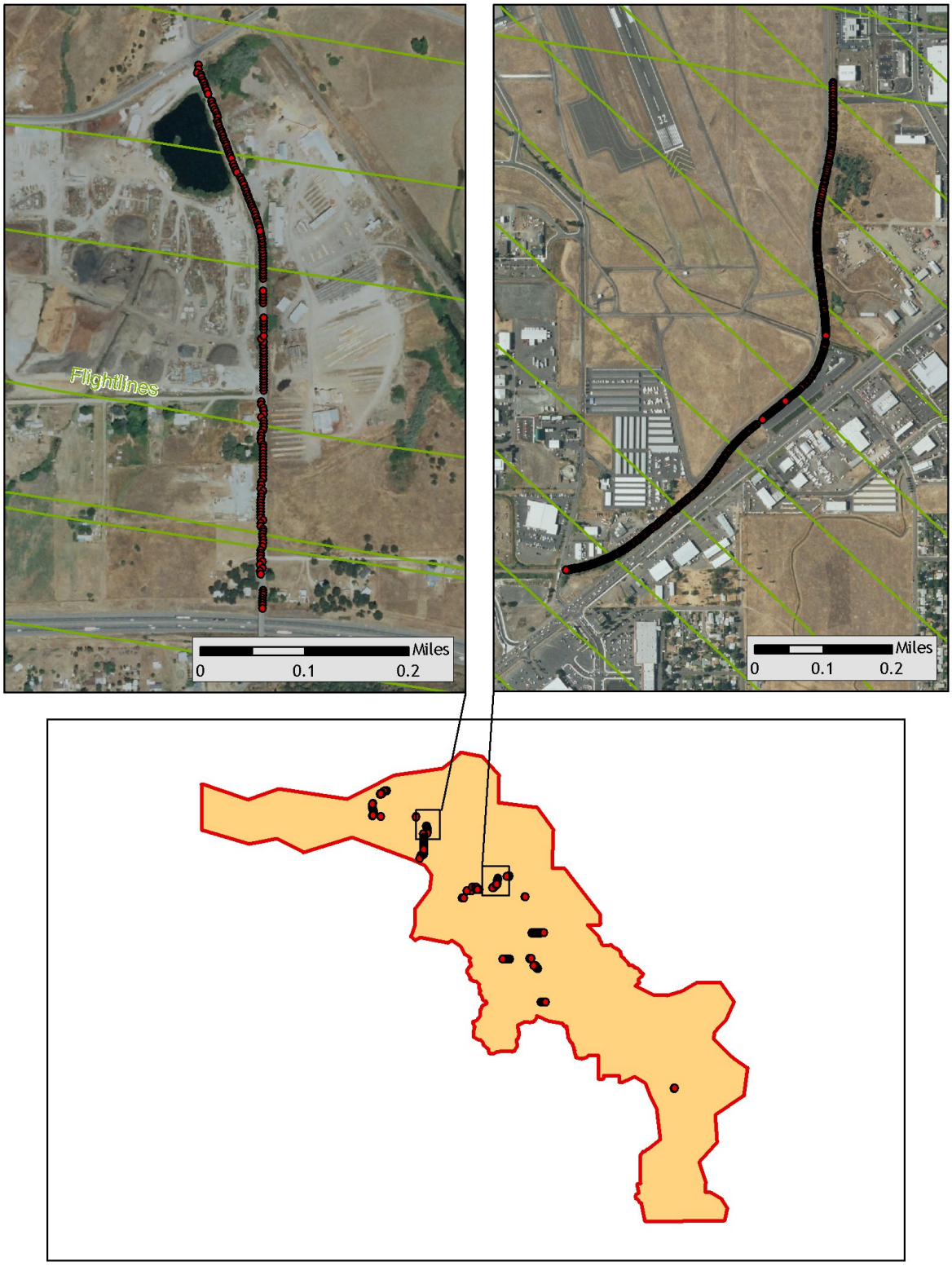


Table 1.1. *Base Station Surveyed Coordinates, (NAD83/NAVD88, OPUS corrected) used for kinematic post-processing of the aircraft GPS data for the Medford Study Area.*

	Datum NAD83 (HARN)		GRS80
Base Stations ID	**Latitude (North)**	**Longitude (West)**	**Ellipsoid Height (m)**
MED2_DB1	42 25 50.59853	123 05 34.91304	295.328
MED2_DB2	42 24 58.05456	123 0 18.31802	359.691
MED2_DB3	42 24 58.22745	123 00 18.882671	359.072
MED2_ALR2	42 21 28.31164	122 51 53.91017	382.632
MED2_ALR1	42 21 28.20521	122 51 53.82115	382.602
MED2_ALR4	42 16 47.76753	122 48 56.21470	425.724
MED2_ALR3	42 16 47.77360	122 48 55.94249	425.841
MED_ALR2	42 08 31.23590	122 36 41.84477	666.179
MED1_ALR1	42 08 31.07794	122 36 41.87488	666.141
OR_HWY_10838	42 21 27.34578	122 51 53.77048	383.001

2. Accuracy

2.1 Relative Accuracy

Relative Accuracy Calibration Results

Relative accuracy statistics are based on the comparison of 384 flightlines and over 7 billion points.

- Project Average = 0.121 ft (0.037 m)
- Median Relative Accuracy = 0.111 ft (0.034 m)
- 1σ Relative Accuracy = 0.124 ft (0.038m)
- 2σ Relative Accuracy = 0.197 ft (0.060 m)

Figure 2.1. *Statistical relative accuracies, non slope-adjusted.*

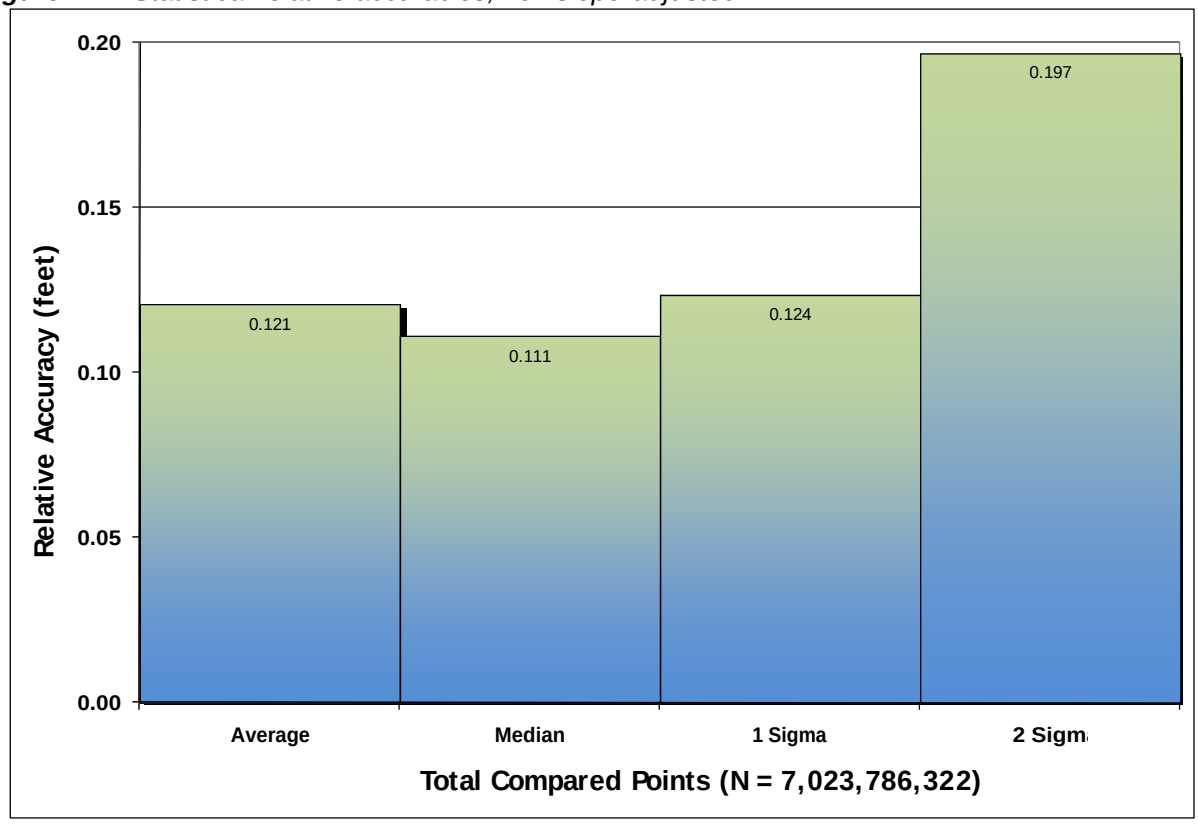
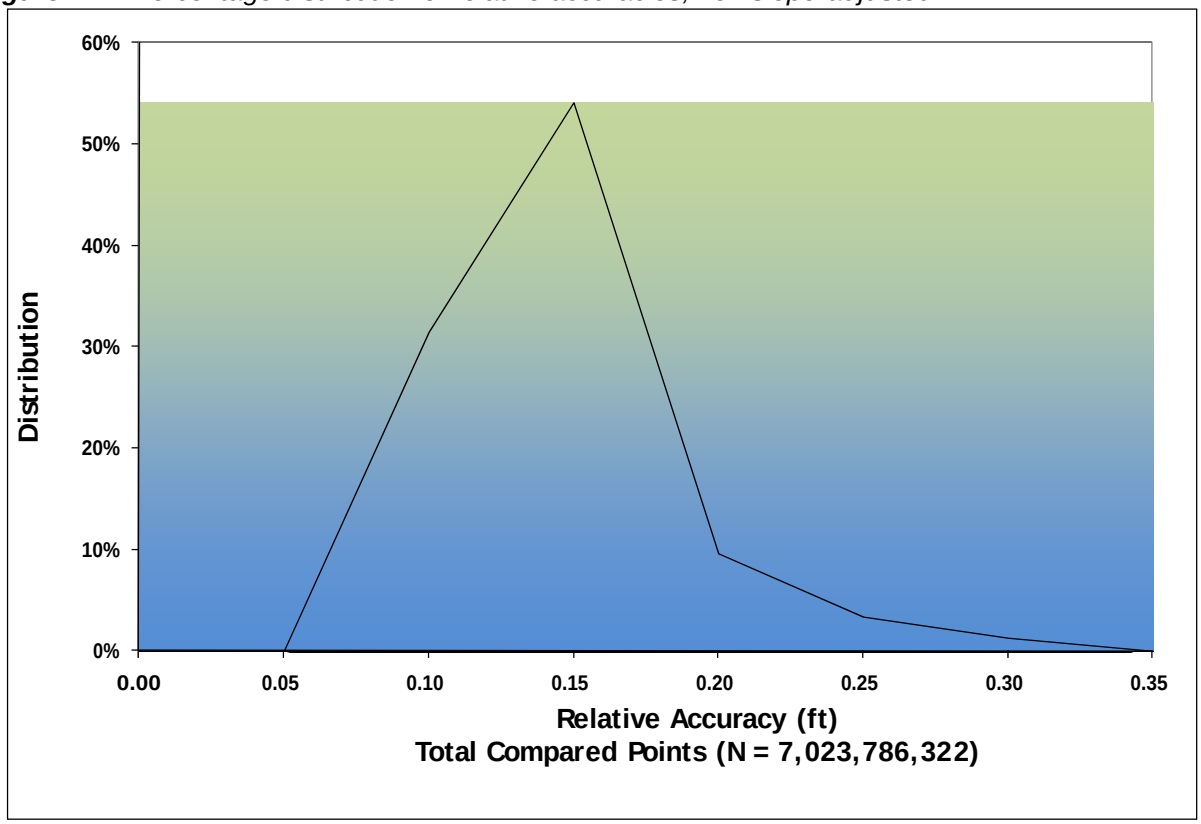


Figure 2.2. *Percentage distribution of relative accuracies, non slope-adjusted.*



2.2 Absolute Accuracy

Absolute accuracy compares known Real Time Kinematic (RTK) ground survey points to the closest laser point. For the Medford Study Area, 2,661 RTK points were collected. Absolute accuracy is reported in **Table 2.1** below**.** Histogram and absolute deviation statistics are reported in **Figures 2.3 and 2.4**.

Table 2.1. *Absolute Accuracy – Deviation between laser points and RTK survey points.*

Sample Size (n): 2,661	
Root Mean Square Error (RMSE): 0.16 ft (0.05m)	
Standard Deviations	**Deviations**
1 sigma (s): 0.15 ft (0.05 m)	**Minimum Δz:** -0.58 ft (-0.18 m)
2 sigma (s): 0.31 ft (0.10 m)	**Maximum Δz:** 0.40 ft (0.12 m)
	Average Δz: 0.13 ft (0.04 m)

Figure 2.3. *Medford Study Area histogram statistics*

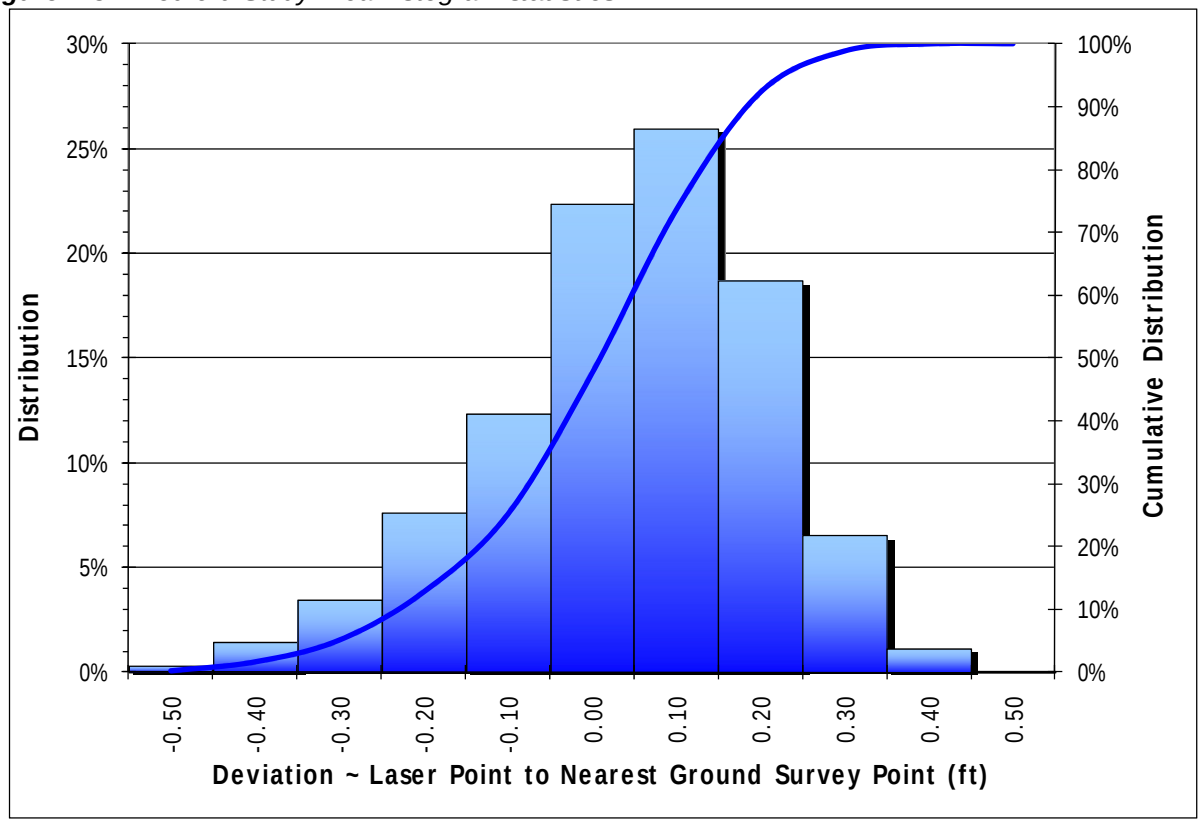
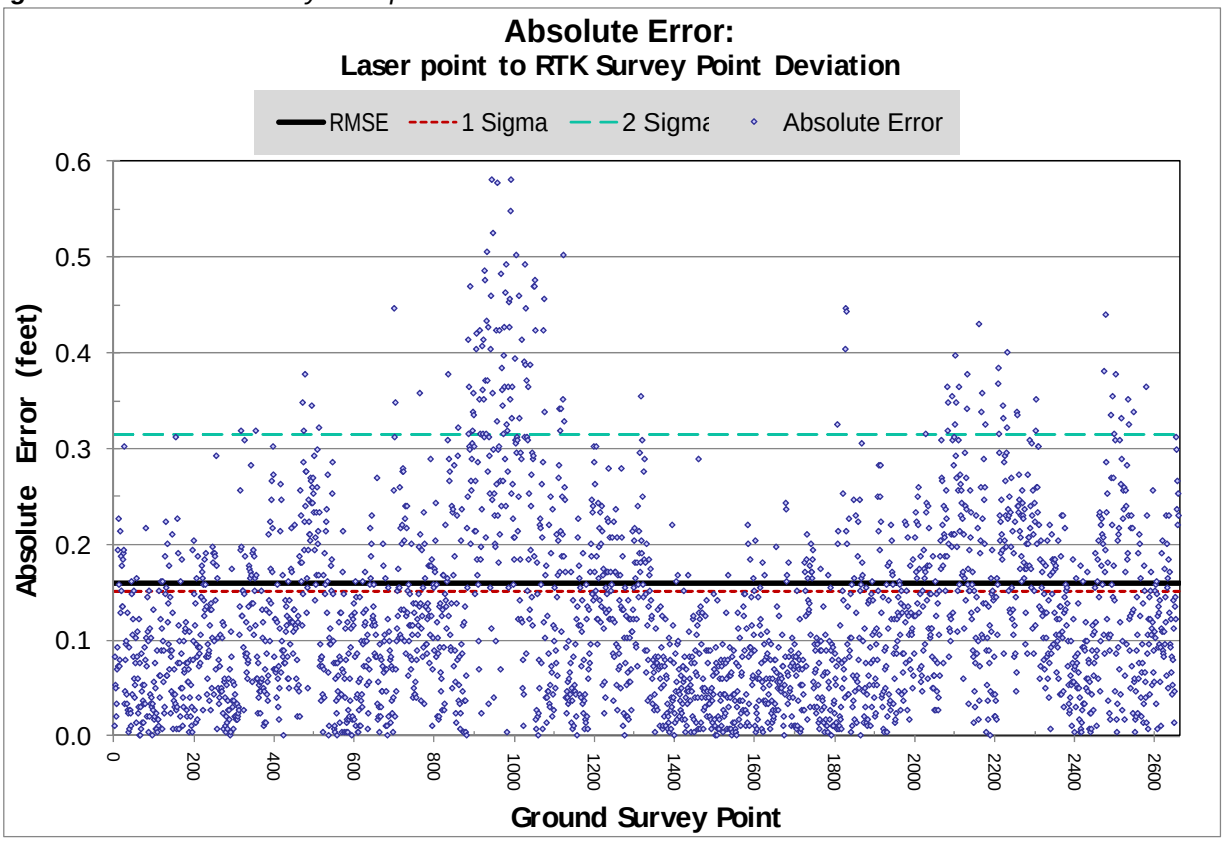


Figure 2.4. *Medford Study Area point absolute deviation statistics.*



3. Data Density/Resolution

3.1 Density Statistics

Some types of surfaces (i.e., dense vegetation or water) may return fewer pulses than the laser originally emitted. Therefore, the delivered density can be less than the native density and vary according to distributions of terrain, land cover and water bodies. Density histograms and maps (**Figures 3.1 – 3.4**) have been calculated based on first return laser point density and ground-classified laser point density.

***Table 3.1**. Average density statistics for the Medford Study Area.*

Average Pulse Density (per square ft)	Average Pulse Density (per square m)	Average Ground Density (per square ft)	Average Ground Density (per square m)
.72	7.79	.22	2.35

***Figure 3.1.** Histogram of first return laser point density.*

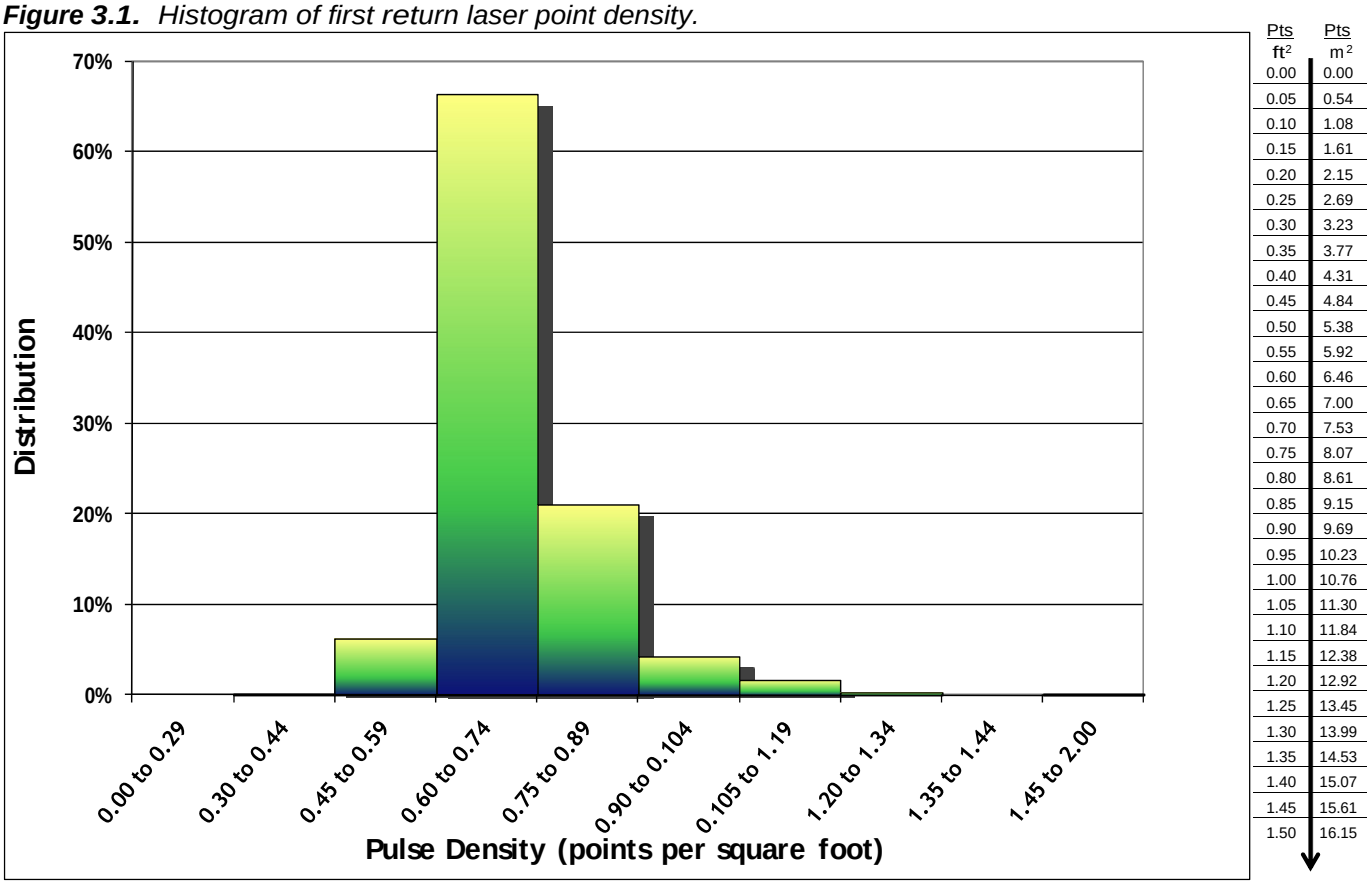
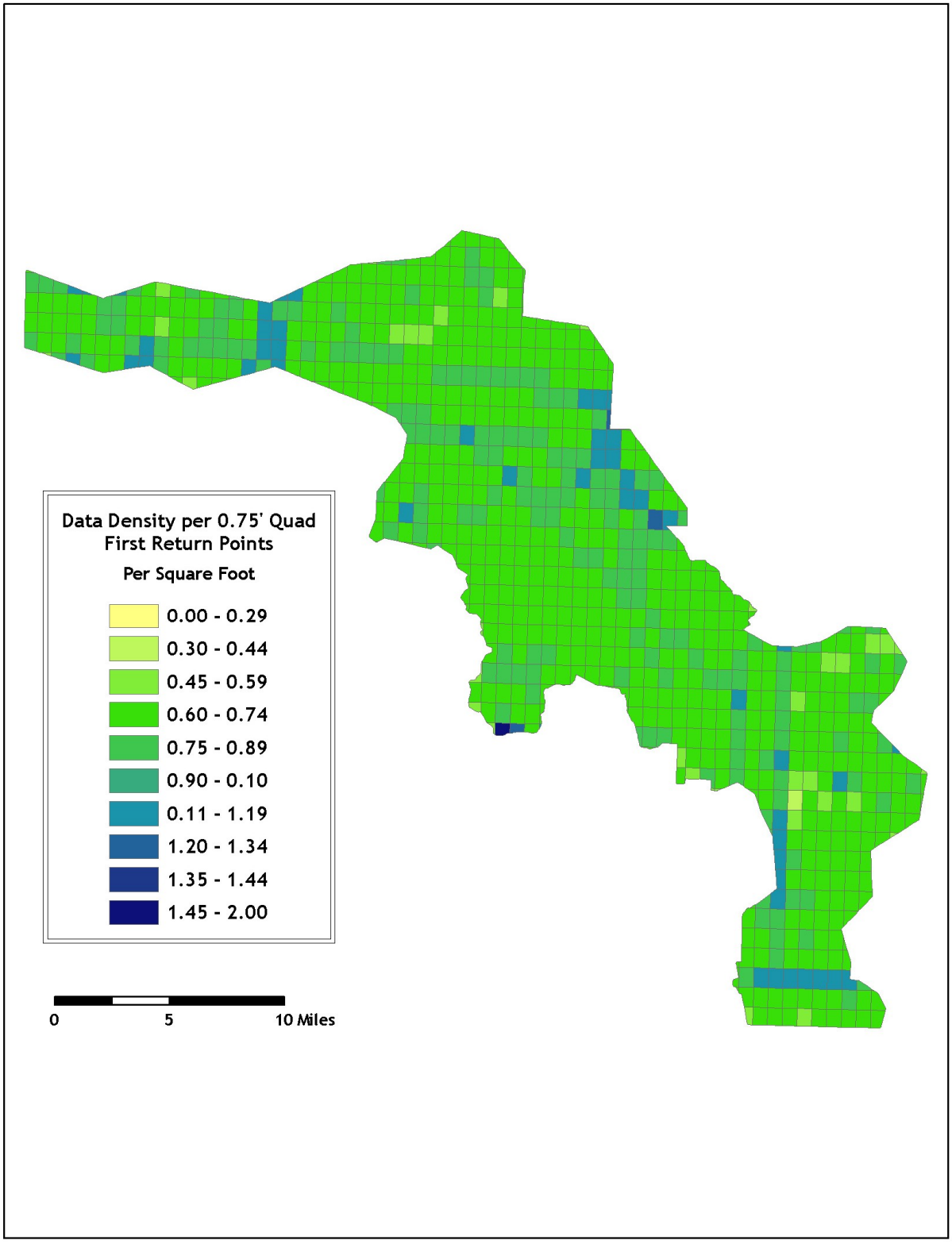


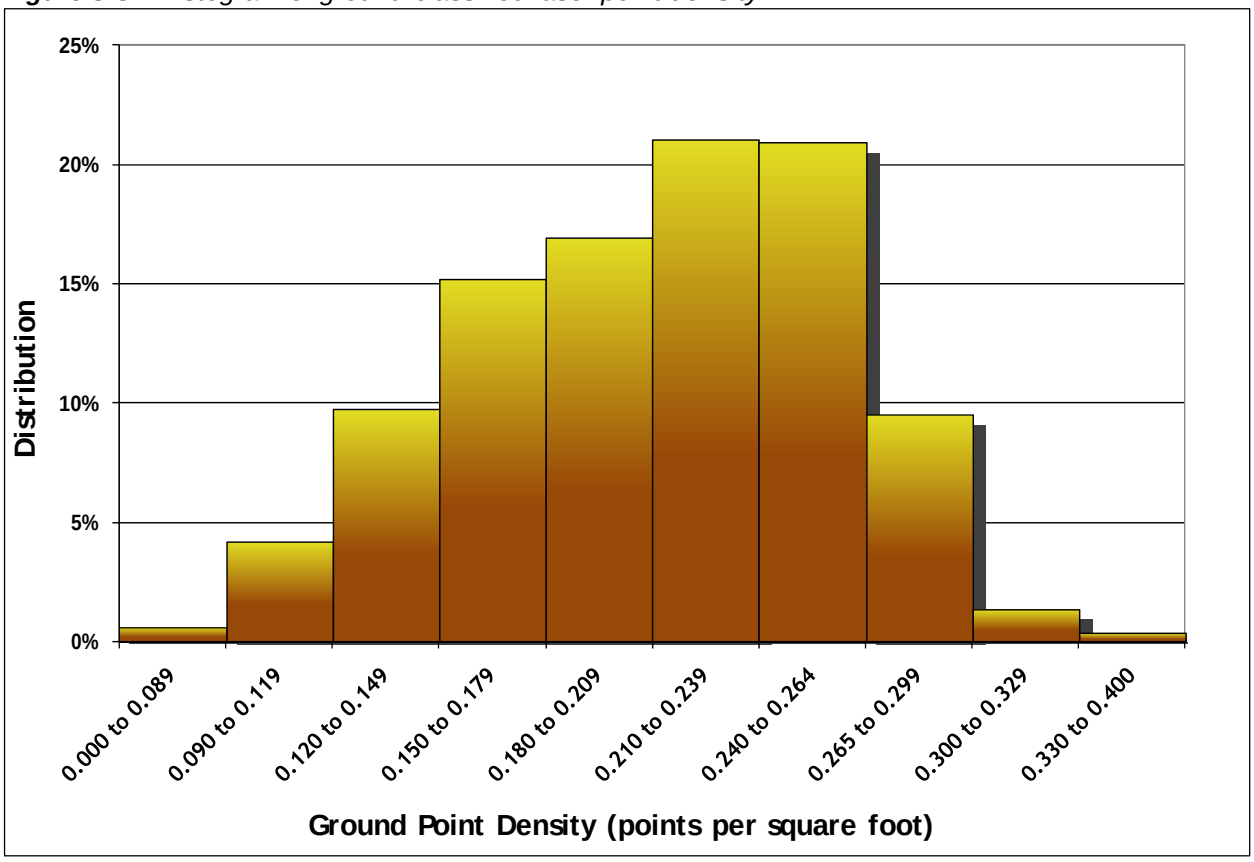
Figure 3.2. *Image shows first return laser point per 0.75' USGS Quad.*



Pts ft²	Pts m²
0.00	0.00
0.05	0.54
0.10	1.08
0.15	1.61
0.20	2.15
0.25	2.69
0.30	3.23
0.35	3.77
0.40	4.31
0.45	4.84
0.50	5.38
0.55	5.92
0.60	6.46
0.65	7.00
0.70	7.53
0.75	8.07
0.80	8.61
0.85	9.15
0.90	9.69
0.95	10.23
1.00	10.76
1.05	11.30
1.10	11.84
1.15	12.38
1.20	12.92
1.25	13.45
1.30	13.99
1.35	14.53
1.40	15.07
1.45	15.61
1.50	16.15

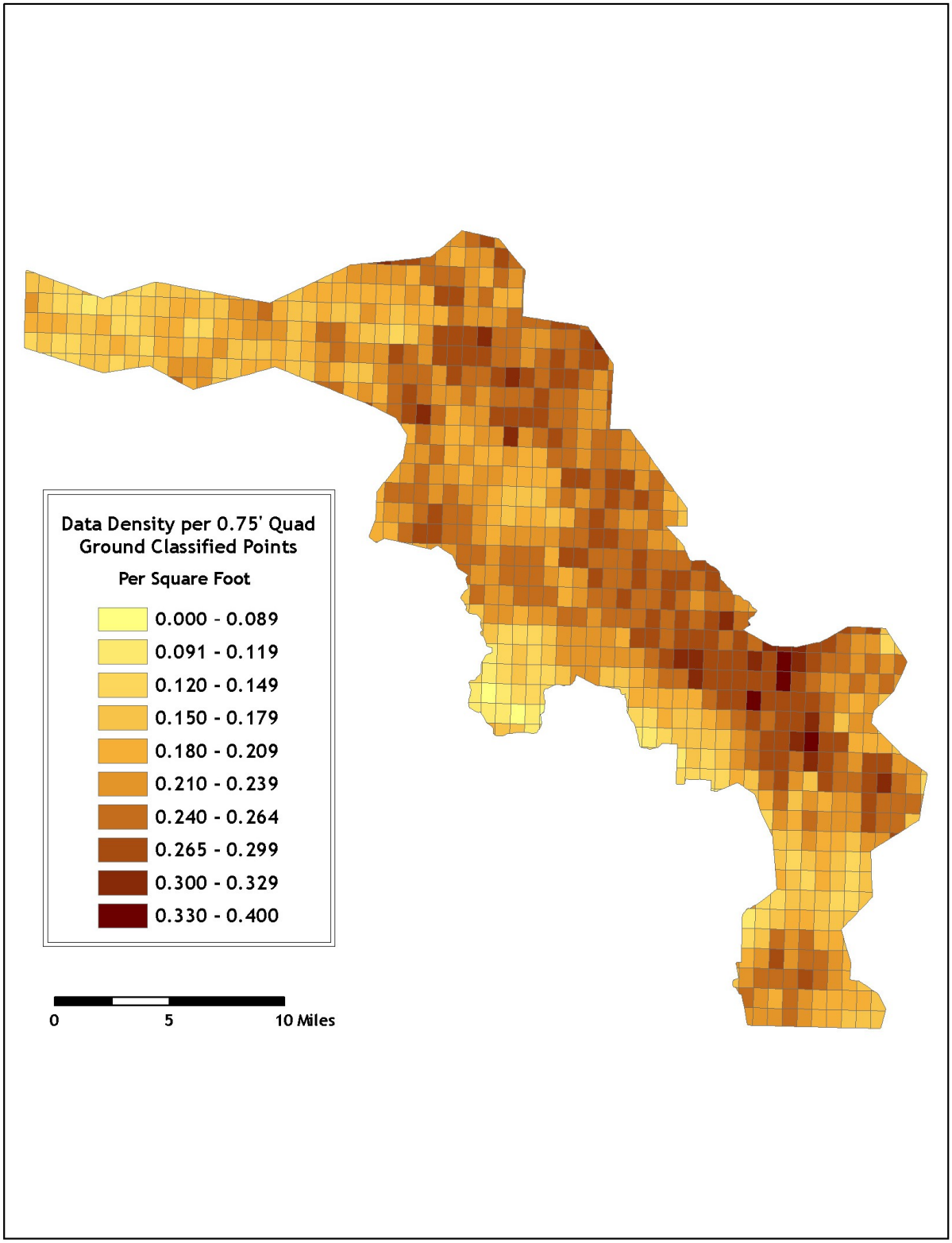
Ground classifications were derived from ground surface modeling. Supervised classifications were performed by reseeding of the ground model where it was determined that the ground model failed, usually under dense vegetation and/or at breaks in terrain, steep slopes and at bin boundaries.

***Figure 3.3**. Histogram of ground-classified laser point density.*



Pts ft^2	Pts m^2
0.00	0.00
0.05	0.54
0.10	1.08
0.15	1.61
0.20	2.15
0.25	2.69
0.30	3.23
0.35	3.77
0.40	4.31
0.45	4.84
0.50	5.38
0.55	5.92
0.60	6.46
0.65	7.00
0.70	7.53
0.75	8.07
0.80	8.61
0.85	9.15
0.90	9.69
0.95	10.23
1.00	10.76
1.05	11.30
1.10	11.84
1.15	12.38
1.20	12.92
1.25	13.45
1.30	13.99
1.35	14.53
1.40	15.07
1.45	15.61
1.50	16.15

Figure 3.4. *Ground-classified laser point density per 0.75' USGS Quad.*



3.2 Selected Samples of Data Density/Resolution

***Figure 3.5**. Quadrants containing overlapping flightlines resulting in high data density.*

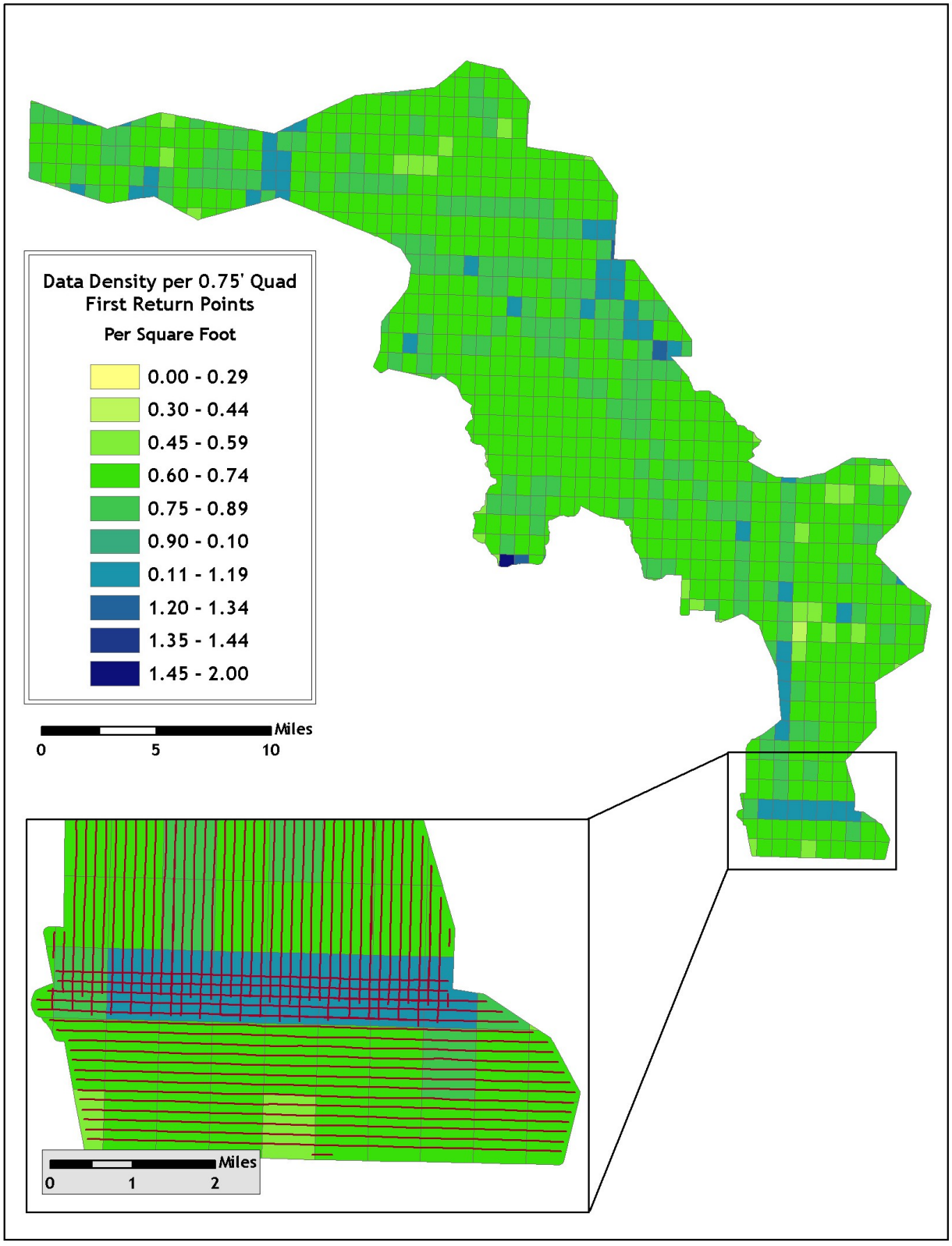
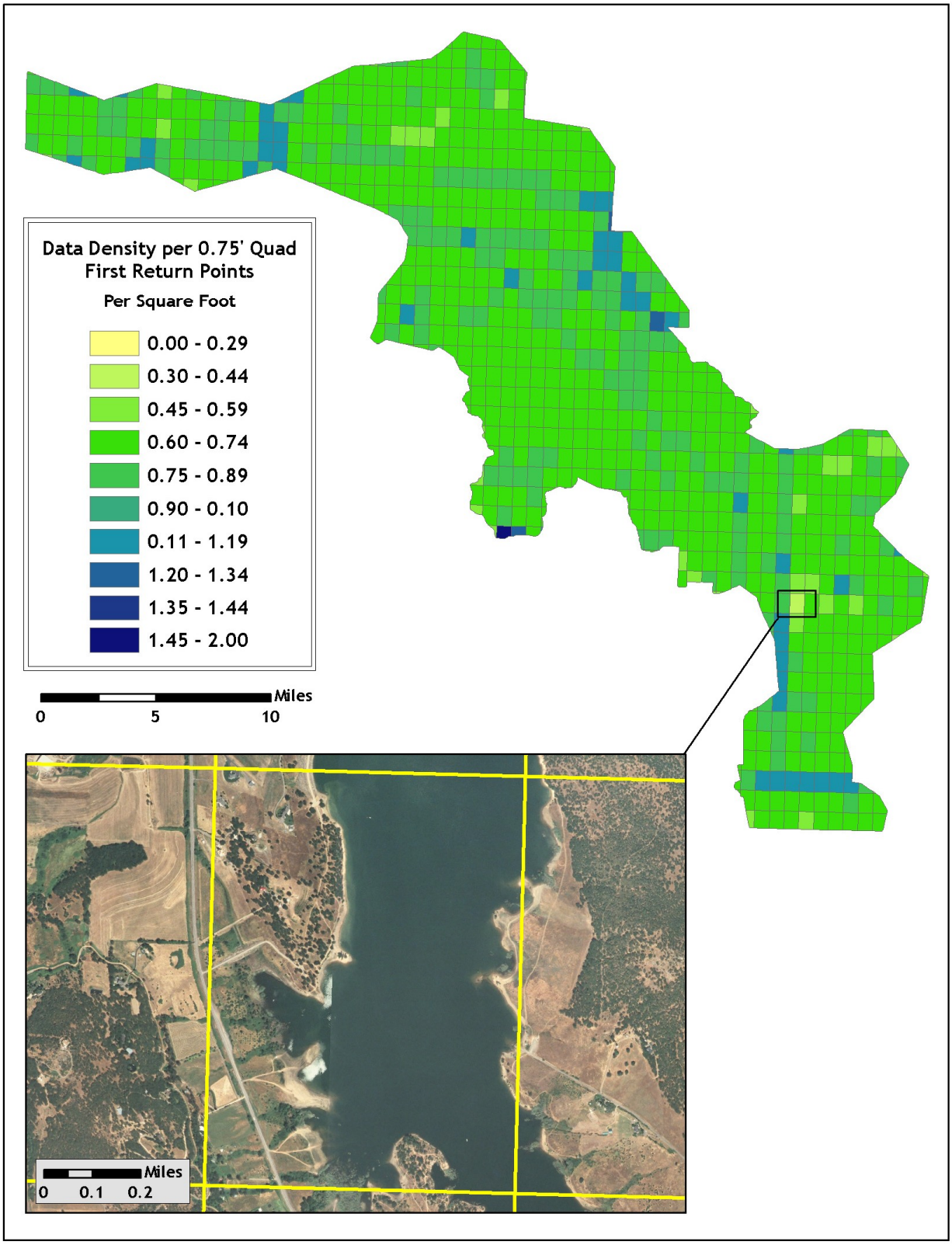


***Figure 3.6**. Quadrant containing low pulse density as a result of a water body.*



4. Selected Imagery

Example areas are presented to show sample imagery (see **Figures 4.1 - 4.3**).

Figure 4.1. Section of the Rogue River located just south of Lower Table Rock. Topmost image derived from highest hit LiDAR, center image from bare earth LiDAR, bottom image derived from NAIP orthophoto.

Figure 4.2. Baseball field complex located off of Interstate-5, south of Medford . Top image derived from highest hit LiDAR and botom image derived from bear earth LiDAR.

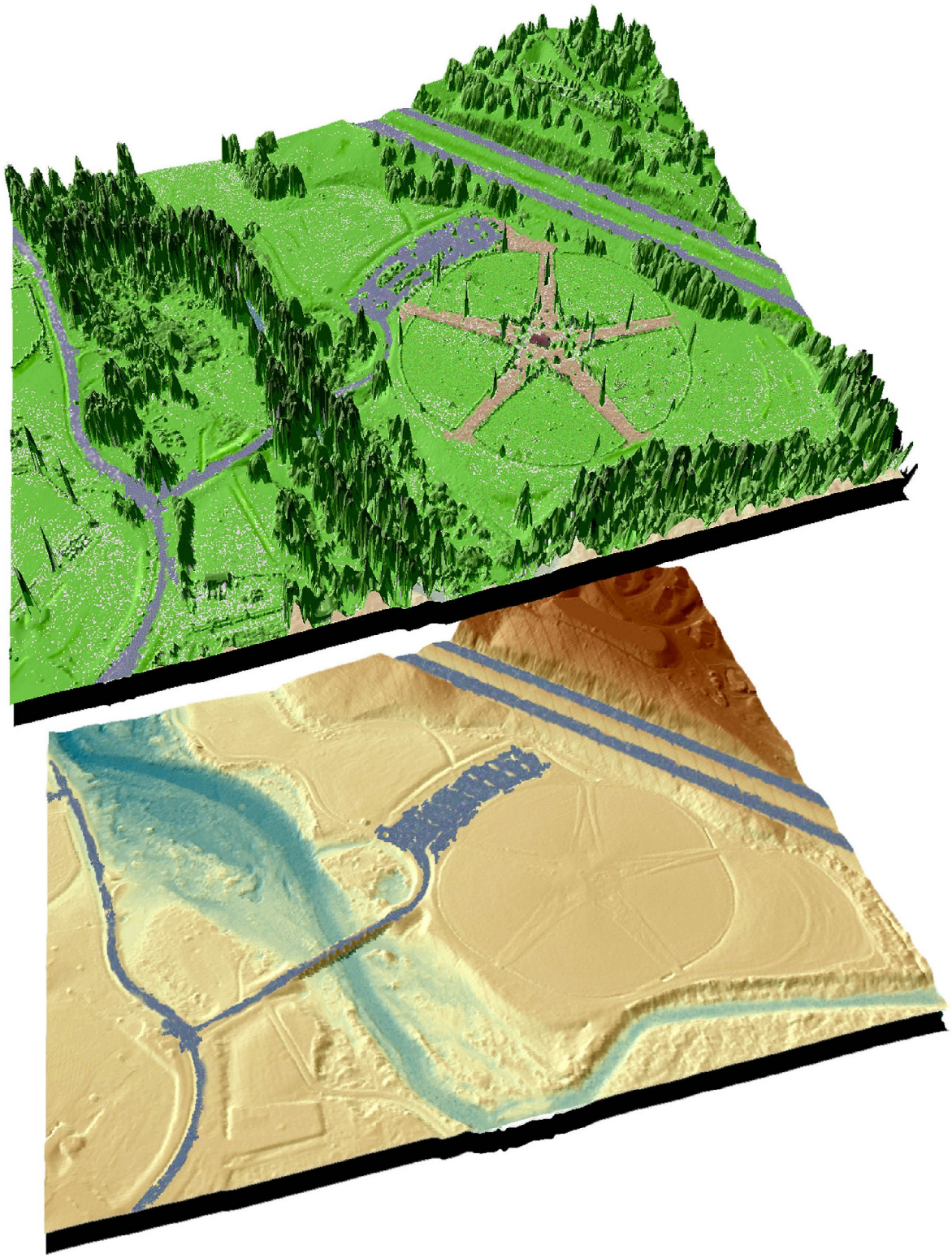


Figure 4.3. Dam at Emigrant Lake, southwest of Ashland. In Delivery Quad 42122B5. Top image derived from highest hit LiDAR and bottom image derived from bare earth LiDAR.