

## C-4.1 Report on Nominal Pulse Spacing (NPS)

The USGS Lidar Base Specification Version 1.3 states: "Assessment and reporting of the NPS are made against single swath, single instrument, first-return-only data, including only the geometrically usable part of the swath and excluding acceptable data voids. Higher net densities of lidar point measurements are being achieved more often by flying multiple passes of the lidar instrument over the project area or flying with large amounts (greater than [ $>$ ] 50 percent) of overlap between swaths, creating a need for a new term to describe total pulse density without being confused with NPS and NPD. This specification will use the terms aggregate nominal pulse spacing (ANPS) and aggregate nominal pulse density (ANPD) to describe the net overall pulse spacing and density, respectively. The required ANPS and ANPD by QL are listed in Table 1. Dependent on the local terrain and land cover conditions in a project, a greater pulse density may be required on specific projects."

**Table 1.** Aggregate nominal pulse spacing and density.

[QL, quality level; pls/m<sup>2</sup>, pulses per square meter; m, meter;  $\leq$ , less than or equal to;  $\geq$ , greater than or equal to]

Quality level	Aggregate nominal pulse spacing (m)	Aggregate nominal pulse density (pls/m <sup>2</sup> )
QL0	$\leq 0.35$	$\geq 8.0$
QL1	$\leq 0.35$	$\geq 8.0$
QL2	$\leq 0.71$	$\geq 2.0$
QL3	$\leq 1.41$	$\geq 0.5$

The purpose of this section is to report on the lidar point density and nominal point spacing by LAS file. Averages by files (not including overlap), project boundary polygons (including overlap), and aggregate project boundary polygons (including overlap) are reported.

[Data Source - Y:\Mapping\Projects\65220171\\_USGS-TX\\_West\\_Texas\Production\Final\\_Client\\_Deliverables\Lot8\\_utm13\point\\_cloud\Swaths](Y:\Mapping\Projects\65220171_USGS-TX_West_Texas\Production\Final_Client_Deliverables\Lot8_utm13\point_cloud\Swaths)

Quality level tested: QL2

File	Number of First Returns	Area	Point Density	NPS
CS_02002.las	306,170,762	103,670,800	2.953/0.274	0.582/1.909
CS_02029.las	318,539,608	103,959,072	3.064/0.285	0.571/1.873
CS_02032.las	318,612,743	103,681,744	3.073/0.285	0.570/1.870
CS_02034.las	304,321,695	99,300,512	3.065/0.285	0.571/1.873

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File	Number of First Returns	Area	Point Density	NPS
CS_02067.las	137,807,176	47,437,616	2.905/0.270	0.587/1.926
CS_02070.las	312,734,120	103,275,840	3.028/0.281	0.575/1.886
CS_02073.las	304,530,707	103,570,064	2.940/0.273	0.583/1.913
CS_02075.las	125,213,562	41,915,280	2.987/0.278	0.579/1.900
CS_02096.las	64,859,394	20,160,752	3.217/0.299	0.558/1.831
CS_02099.las	60,396,838	20,131,824	3.000/0.279	0.577/1.893
CS_02122.las	312,882,501	104,881,296	2.983/0.277	0.579/1.900
CS_02123.las	326,626,116	104,636,720	3.122/0.290	0.566/1.857
CS_02126.las	295,121,653	103,935,104	2.839/0.264	0.593/1.946
CS_02129.las	295,732,984	103,287,536	2.863/0.266	0.591/1.939
CS_02132.las	316,125,746	103,753,440	3.047/0.283	0.573/1.880
CS_02134.las	1,464,074	217,792	6.722/0.624	0.386/1.266
CS_02153.las	13,254,555	3,746,688	3.538/0.329	0.532/1.745
CS_02156.las	52,268,572	18,397,136	2.841/0.264	0.593/1.946
CS_02160.las	53,588,460	18,273,888	2.933/0.272	0.584/1.916
CS_02170.las	295,210,700	103,975,984	2.839/0.264	0.593/1.946
CS_02186.las	301,512,030	104,465,760	2.886/0.268	0.589/1.932
CS_02187.las	308,334,898	104,468,144	2.951/0.274	0.582/1.909
CS_02188.las	299,834,551	105,100,752	2.853/0.265	0.592/1.942
CS_02189.las	311,465,099	104,841,136	2.971/0.276	0.580/1.903
CS_02193.las	329,429,357	104,128,240	3.164/0.294	0.562/1.844
CS_02197.las	304,721,164	103,306,480	2.950/0.274	0.582/1.909
CS_02200.las	303,416,379	103,938,160	2.919/0.271	0.585/1.919
CS_02204.las	174,100,050	49,562,768	3.513/0.326	0.534/1.752
CS_02222.las	59,950,753	19,616,832	3.056/0.284	0.572/1.877
CS_02225.las	61,592,112	19,812,400	3.109/0.289	0.567/1.860
CS_02229.las	58,386,435	20,171,952	2.894/0.269	0.588/1.929
CS_02240.las	311,583,824	103,997,056	2.996/0.278	0.578/1.896
CS_02257.las	317,272,794	104,753,216	3.029/0.281	0.575/1.886
CS_02258.las	323,506,236	104,415,216	3.098/0.288	0.568/1.864
CS_02259.las	361,345,544	105,087,488	3.439/0.319	0.539/1.768
CS_02260.las	323,184,284	104,683,264	3.087/0.287	0.569/1.867
CS_02264.las	291,702,017	104,063,440	2.803/0.260	0.597/1.959

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File	Number of First Returns	Area	Point Density	NPS
CS_02268.las	307,076,312	103,411,392	2.969/0.276	0.580/1.903
CS_02271.las	300,205,542	103,856,576	2.891/0.269	0.588/1.929
CS_02275.las	432,431,632	138,302,080	3.127/0.291	0.566/1.857
CS_02278.las	413,535,769	135,014,496	3.063/0.285	0.571/1.873
CS_02294.las	51,333,219	18,042,720	2.845/0.264	0.593/1.946
CS_02297.las	53,196,134	18,435,248	2.886/0.268	0.589/1.932
CS_02301.las	76,046,919	24,976,080	3.045/0.283	0.573/1.880
CS_02310.las	294,722,700	104,310,064	2.825/0.262	0.595/1.952
CS_02324.las	301,250,023	104,069,808	2.895/0.269	0.588/1.929
CS_02325.las	313,071,133	103,546,736	3.023/0.281	0.575/1.886
CS_02326.las	247,819,797	85,954,784	2.883/0.268	0.589/1.932
CS_02327.las	308,911,904	104,170,848	2.965/0.275	0.581/1.906
CS_02331.las	317,370,834	104,099,696	3.049/0.283	0.573/1.880
CS_02338.las	317,059,832	103,599,776	3.060/0.284	0.572/1.877
CS_02345.las	523,161,980	135,700,528	3.855/0.358	0.509/1.670
CS_02359.las	60,378,322	20,021,760	3.016/0.280	0.576/1.890
CS_02361.las	60,356,140	19,612,304	3.077/0.286	0.570/1.870
CS_02365.las	61,735,357	20,961,136	2.945/0.274	0.583/1.913
CS_02373.las	308,390,470	104,269,808	2.958/0.275	0.581/1.906
CS_02387.las	333,744,916	104,489,760	3.194/0.297	0.560/1.837
CS_02388.las	331,095,399	104,124,304	3.180/0.295	0.561/1.841
CS_02390.las	211,252,546	66,605,664	3.172/0.295	0.562/1.844
CS_02394.las	294,648,038	103,702,784	2.841/0.264	0.593/1.946
CS_02400.las	294,521,885	103,480,336	2.846/0.264	0.593/1.946
CS_02403.las	427,892,013	138,753,328	3.084/0.287	0.569/1.867
CS_02405.las	415,496,081	133,992,608	3.101/0.288	0.568/1.864
CS_02421.las	54,169,113	18,553,824	2.920/0.271	0.585/1.919
CS_02425.las	66,324,312	21,547,648	3.078/0.286	0.570/1.870
CS_02446.las	302,393,618	103,288,224	2.928/0.272	0.584/1.916
CS_02447.las	324,868,851	104,101,536	3.121/0.290	0.566/1.857
CS_02458.las	307,671,644	102,995,472	2.987/0.278	0.579/1.900
CS_02462.las	452,348,119	139,338,048	3.246/0.302	0.555/1.821
CS_02464.las	548,523,037	134,816,320	4.069/0.378	0.496/1.627

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File	Number of First Returns	Area	Point Density	NPS
CS_02476.las	51,691,053	18,344,016	2.818/0.262	0.596/1.955
CS_02483.las	69,956,577	22,874,160	3.058/0.284	0.572/1.877
CS_02491.las	299,115,857	104,507,488	2.862/0.266	0.591/1.939
CS_02505.las	335,022,495	103,757,376	3.229/0.300	0.557/1.827
CS_02506.las	322,351,879	104,717,952	3.078/0.286	0.570/1.870
CS_02515.las	308,987,416	103,390,688	2.989/0.278	0.578/1.896
CS_02519.las	424,510,790	138,541,840	3.064/0.285	0.571/1.873
CS_02521.las	420,290,266	133,775,728	3.142/0.292	0.564/1.850
CS_02539.las	65,861,544	21,332,848	3.087/0.287	0.569/1.867
CS_02547.las	306,819,422	104,185,040	2.945/0.274	0.583/1.913
CS_02553.las	293,140,212	104,788,416	2.797/0.260	0.598/1.962
CS_02555.las	501,642,608	155,177,184	3.233/0.300	0.556/1.824
CS_02561.las	299,276,504	103,620,544	2.888/0.268	0.588/1.929
CS_02562.las	309,248,444	104,434,032	2.961/0.275	0.581/1.906
CS_02566.las	318,167,285	103,771,072	3.066/0.285	0.571/1.873
CS_02574.las	448,254,021	138,653,408	3.233/0.300	0.556/1.824
CS_02576.las	530,923,657	134,105,056	3.959/0.368	0.503/1.650
CS_02592.las	75,915,129	24,433,024	3.107/0.289	0.567/1.860
CS_02605.las	303,535,914	104,772,416	2.897/0.269	0.588/1.929
CS_02607.las	461,745,887	156,557,472	2.949/0.274	0.582/1.909
CS_02613.las	344,652,017	104,407,568	3.301/0.307	0.550/1.804
CS_02614.las	321,967,512	104,729,360	3.074/0.286	0.570/1.870
CS_02617.las	296,336,095	103,571,520	2.861/0.266	0.591/1.939
CS_02622.las	18,114,102	5,839,440	3.102/0.288	0.568/1.864
CS_02625.las	424,156,071	137,931,040	3.075/0.286	0.570/1.870
CS_02627.las	433,698,081	132,183,488	3.281/0.305	0.552/1.811
CS_02641.las	60,929,769	21,050,960	2.894/0.269	0.588/1.929
CS_02652.las	320,335,447	105,056,976	3.049/0.283	0.573/1.880
CS_02655.las	499,387,876	155,514,048	3.211/0.298	0.558/1.831
CS_02661.las	313,667,713	103,433,120	3.033/0.282	0.574/1.883
CS_02662.las	314,848,155	104,499,696	3.013/0.280	0.576/1.890
CS_02673.las	444,772,770	138,318,992	3.216/0.299	0.558/1.831
CS_02675.las	541,140,972	133,083,824	4.066/0.378	0.496/1.627

## C-4.1 Report on Nominal Pulse Spacing (NPS) - continued

File	Number of First Returns	Area	Point Density	NPS
CS_02688.las	65,167,573	21,922,976	2.973/0.276	0.580/1.903
CS_02700.las	299,024,444	104,785,472	2.854/0.265	0.592/1.942
CS_02710.las	331,780,703	104,842,736	3.165/0.294	0.562/1.844
CS_02719.las	390,167,228	129,836,528	3.005/0.279	0.577/1.893
CS_02721.las	424,782,331	133,018,272	3.193/0.297	0.560/1.837
CS_02744.las	319,082,897	104,962,592	3.040/0.282	0.574/1.883
CS_02748.las	468,745,997	156,062,512	3.004/0.279	0.577/1.893
CS_02755.las	304,971,408	104,414,976	2.921/0.271	0.585/1.919
CS_02764.las	454,551,244	138,559,504	3.281/0.305	0.552/1.811
CS_02789.las	293,037,064	104,612,048	2.801/0.260	0.597/1.959
CS_02925.las	68,952,340	25,561,152	2.698/0.251	0.609/1.998
CS_02965.las	46,154,096	17,538,736	2.632/0.245	0.616/2.021
CS_02990.las	988,778	303,408	3.259/0.303	0.554/1.818
CS_03028.las	528,915,813	135,922,592	3.891/0.361	0.507/1.663
CS_03031.las	453,370,545	139,074,560	3.260/0.303	0.554/1.818
CS_09000.las	27,208,856	8,707,552	3.125/0.290	0.566/1.857
Average			3.070/0.285	0.571/1.873
			pp Square Meter/ pp Square US Survey Foot	Meter/ US Survey Feet
Lot_8	32,726,380,524	8,049,293,002	4.066/0.378	0.496/1.627
Aggregate	32,726,380,524	8,049,293,002	4.066/0.378	0.496/1.627
			pp Square Meter/ pp Square US Survey Foot	Meter/ US Survey Feet

\* - indicates a swath whose NPS and Point Density were brought up to specifications due to the inclusion of one or more re-flight swaths.