

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/m², 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 ²)
QL0	≤ 0.35	≥ 8.0
QL1	≤ 0.35	≥ 8.0
QL2	≤ 0.71	≥ 2.0
QL3	≤ 1.41	≥ 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 - Z:\MARS_QC\2900112_Lot_8\Generated_Swath](#)

Quality level tested: QL2

File	Number of First Returns	Area	Point Density	NPS
CS_00103.las	83,844,706	25,601,968	3.275/0.304	0.553/1.814
CS_00104.las	84,784,167	25,953,776	3.267/0.304	0.553/1.814
CS_00105.las	85,341,028	25,676,272	3.324/0.309	0.549/1.801
CS_00106.las	86,296,268	25,770,128	3.349/0.311	0.546/1.791
CS_00107.las	85,941,557	25,698,880	3.344/0.311	0.547/1.795

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File	Number of First Returns	Area	Point Density	NPS
CS_00108.las	84,936,416	25,500,416	3.331/0.309	0.548/1.798
CS_00109.las	89,717,013	25,526,416	3.515/0.327	0.533/1.749
CS_00110.las	82,427,473	25,716,992	3.205/0.298	0.559/1.834
CS_00111.las	91,196,157	25,549,136	3.569/0.332	0.529/1.736
CS_00112.las	83,199,006	25,551,872	3.256/0.302	0.554/1.818
CS_00113.las	85,937,038	25,502,288	3.370/0.313	0.545/1.788
CS_00114.las	84,180,277	25,355,664	3.320/0.308	0.549/1.801
CS_00115.las	87,821,116	25,353,984	3.464/0.322	0.537/1.762
CS_00116.las	83,480,161	25,408,240	3.286/0.305	0.552/1.811
CS_00117.las	91,877,566	25,342,320	3.625/0.337	0.525/1.722
CS_00118.las	81,325,569	25,694,976	3.165/0.294	0.562/1.844
CS_00119.las	87,488,565	25,737,904	3.399/0.316	0.542/1.778
CS_00120.las	84,562,964	25,517,456	3.314/0.308	0.549/1.801
CS_00121.las	88,700,907	25,679,728	3.454/0.321	0.538/1.765
CS_00122.las	87,183,501	25,444,256	3.426/0.318	0.540/1.772
CS_00123.las	83,933,172	25,264,240	3.322/0.309	0.549/1.801
CS_00124.las	83,184,231	25,537,872	3.257/0.303	0.554/1.818
CS_00125.las	83,709,376	25,589,520	3.271/0.304	0.553/1.814
CS_00126.las	83,904,127	25,215,280	3.328/0.309	0.548/1.798
CS_00127.las	82,650,670	25,338,432	3.262/0.303	0.554/1.818
CS_00128.las	80,817,082	25,002,784	3.232/0.300	0.556/1.824
CS_00129.las	83,818,520	25,084,512	3.341/0.310	0.547/1.795
CS_00130.las	78,500,852	24,974,272	3.143/0.292	0.564/1.850
CS_00131.las	84,937,687	24,924,720	3.408/0.317	0.542/1.778
CS_00132.las	85,178,747	24,864,880	3.426/0.318	0.540/1.772
CS_00133.las	85,576,916	24,839,712	3.445/0.320	0.539/1.768
CS_00134.las	77,127,926	24,776,128	3.113/0.289	0.567/1.860
CS_00135.las	76,731,537	24,739,184	3.102/0.288	0.568/1.864
CS_00136.las	88,291,466	24,807,184	3.559/0.331	0.530/1.739
CS_00137.las	79,134,455	24,669,632	3.208/0.298	0.558/1.831
CS_00138.las	88,923,855	24,659,808	3.606/0.335	0.527/1.729
CS_00139.las	81,915,773	24,621,824	3.327/0.309	0.548/1.798
CS_00140.las	87,337,938	24,523,024	3.561/0.331	0.530/1.739

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File	Number of First Returns	Area	Point Density	NPS
CS_00141.las	80,754,653	24,616,640	3.280/0.305	0.552/1.811
CS_00142.las	87,456,781	24,550,560	3.562/0.331	0.530/1.739
CS_00143.las	80,762,861	24,597,376	3.283/0.305	0.552/1.811
CS_00144.las	89,431,079	24,447,184	3.658/0.340	0.523/1.716
CS_00145.las	80,156,758	24,443,568	3.279/0.305	0.552/1.811
CS_00146.las	90,029,582	24,381,824	3.692/0.343	0.520/1.706
CS_00147.las	78,160,766	24,457,456	3.196/0.297	0.559/1.834
CS_00148.las	76,618,172	24,405,808	3.139/0.292	0.564/1.850
CS_00149.las	88,473,360	24,297,568	3.641/0.338	0.524/1.719
CS_00150.las	78,033,268	24,528,848	3.181/0.296	0.561/1.841
CS_00151.las	52,707,404	14,712,848	3.582/0.333	0.528/1.732
CS_00152.las	18,380,633	5,661,488	3.247/0.302	0.555/1.821
CS_00153.las	23,843,662	7,079,664	3.368/0.313	0.545/1.788
CS_00154.las	23,444,283	7,096,544	3.304/0.307	0.550/1.804
CS_00155.las	22,860,541	7,019,136	3.257/0.303	0.554/1.818
CS_00156.las	23,837,323	6,961,968	3.424/0.318	0.540/1.772
CS_00157.las	21,911,475	6,972,272	3.143/0.292	0.564/1.850
CS_00158.las	22,387,466	6,913,904	3.238/0.301	0.556/1.824
CS_00159.las	23,358,519	6,945,488	3.363/0.312	0.545/1.788
CS_00160.las	23,515,242	6,899,040	3.408/0.317	0.542/1.778
CS_00161.las	21,794,045	6,927,856	3.146/0.292	0.564/1.850
CS_00162.las	23,492,102	6,826,464	3.441/0.320	0.539/1.768
CS_00163.las	21,733,286	6,880,960	3.158/0.293	0.563/1.847
CS_00164.las	24,019,483	6,809,232	3.527/0.328	0.532/1.745
CS_00165.las	21,254,912	6,764,400	3.142/0.292	0.564/1.850
CS_00166.las	23,878,433	6,793,808	3.515/0.327	0.533/1.749
CS_00167.las	20,038,750	6,643,952	3.016/0.280	0.576/1.890
CS_00168.las	20,298,408	6,702,160	3.029/0.281	0.575/1.886
CS_00169.las	22,911,626	6,616,944	3.463/0.322	0.537/1.762
CS_00170.las	20,444,092	6,643,552	3.077/0.286	0.570/1.870
CS_00171.las	16,755,576	5,773,696	2.902/0.270	0.587/1.926
CS_00172.las	21,158,385	6,683,344	3.166/0.294	0.562/1.844
CS_00173.las	24,081,349	6,705,408	3.591/0.334	0.528/1.732

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File	Number of First Returns	Area	Point Density	NPS
CS_00174.las	3,245,610	616,256	5.267/0.489	0.436/1.430
CS_00175.las	23,427,178	6,677,088	3.509/0.326	0.534/1.752
CS_00176.las	30,518,182	11,387,312	2.680/0.249	0.611/2.005
CS_00177.las	62,112,479	22,803,152	2.724/0.253	0.606/1.988
CS_00178.las	69,776,632	25,350,544	2.752/0.256	0.603/1.978
CS_00179.las	70,658,467	25,293,936	2.793/0.259	0.598/1.962
CS_00180.las	72,295,688	25,442,864	2.841/0.264	0.593/1.946
CS_00181.las	71,497,525	25,315,616	2.824/0.262	0.595/1.952
CS_00182.las	72,132,879	25,681,904	2.809/0.261	0.597/1.959
CS_00183.las	69,911,955	25,260,848	2.768/0.257	0.601/1.972
CS_00184.las	71,493,016	25,336,592	2.822/0.262	0.595/1.952
CS_00185.las	69,047,395	25,301,152	2.729/0.254	0.605/1.985
CS_00186.las	73,069,952	25,116,960	2.909/0.270	0.586/1.923
CS_00187.las	70,250,908	25,434,176	2.762/0.257	0.602/1.975
CS_00188.las	70,432,945	25,023,696	2.815/0.262	0.596/1.955
CS_00189.las	71,392,117	25,104,304	2.844/0.264	0.593/1.946
CS_00190.las	70,630,610	24,964,592	2.829/0.263	0.595/1.952
CS_00191.las	70,316,033	25,056,736	2.806/0.261	0.597/1.959
CS_00192.las	71,663,759	25,182,800	2.846/0.264	0.593/1.946
CS_00193.las	71,416,437	24,749,456	2.886/0.268	0.589/1.932
CS_00194.las	69,553,208	24,886,192	2.795/0.260	0.598/1.962
CS_00195.las	72,391,483	24,816,832	2.917/0.271	0.586/1.923
CS_00196.las	71,053,993	25,083,648	2.833/0.263	0.594/1.949
CS_00197.las	68,162,206	24,963,328	2.730/0.254	0.605/1.985
CS_00198.las	72,445,212	26,571,856	2.726/0.253	0.606/1.988
CS_00199.las	75,577,106	26,265,744	2.877/0.267	0.590/1.936
CS_00200.las	76,444,232	26,522,384	2.882/0.268	0.589/1.932
CS_00201.las	69,556,016	24,706,928	2.815/0.262	0.596/1.955
CS_00202.las	74,171,851	26,895,856	2.758/0.256	0.602/1.975
CS_00203.las	73,175,443	26,732,784	2.737/0.254	0.604/1.982
CS_00204.las	69,292,786	24,794,400	2.795/0.260	0.598/1.962
CS_00205.las	75,200,203	26,543,136	2.833/0.263	0.594/1.949
CS_00206.las	68,424,708	24,584,592	2.783/0.259	0.599/1.965

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File	Number of First Returns	Area	Point Density	NPS
CS_00207.las	69,577,625	24,755,632	2.811/0.261	0.596/1.955
CS_00208.las	75,350,791	26,211,040	2.875/0.267	0.590/1.936
CS_00209.las	90,570,411	25,864,704	3.502/0.325	0.534/1.752
CS_00210.las	90,504,899	26,227,840	3.451/0.321	0.538/1.765
CS_00211.las	84,746,018	26,068,352	3.251/0.302	0.555/1.821
CS_00212.las	86,519,455	26,100,944	3.315/0.308	0.549/1.801
CS_00213.las	88,686,780	25,864,656	3.429/0.319	0.540/1.772
CS_00214.las	84,829,054	25,958,384	3.268/0.304	0.553/1.814
CS_00215.las	83,686,991	25,876,256	3.234/0.300	0.556/1.824
CS_00216.las	83,387,770	25,835,040	3.228/0.300	0.557/1.827
CS_00217.las	87,520,885	25,981,728	3.369/0.313	0.545/1.788
CS_00218.las	86,700,907	25,981,232	3.337/0.310	0.547/1.795
CS_00219.las	85,417,196	25,844,384	3.305/0.307	0.550/1.804
CS_00220.las	448,871,073	102,567,968	4.376/0.407	0.478/1.568
CS_00221.las	304,261,250	102,488,784	2.969/0.276	0.580/1.903
CS_00222.las	53,918,324	17,131,328	3.147/0.292	0.564/1.850
CS_00223.las	299,848,550	102,978,080	2.912/0.271	0.586/1.923
CS_00224.las	440,363,064	103,804,528	4.242/0.394	0.486/1.594
CS_00225.las	294,479,363	102,129,360	2.883/0.268	0.589/1.932
CS_00226.las	293,857,926	102,563,616	2.865/0.266	0.591/1.939
CS_00227.las	326,758,024	102,729,856	3.181/0.296	0.561/1.841
CS_00228.las	334,349,794	103,402,624	3.233/0.300	0.556/1.824
CS_00229.las	294,665,805	103,248,336	2.854/0.265	0.592/1.942
CS_00230.las	294,881,245	103,557,664	2.848/0.265	0.593/1.946
CS_00231.las	297,754,702	103,924,928	2.865/0.266	0.591/1.939
CS_00232.las	290,843,531	103,277,840	2.816/0.262	0.596/1.955
CS_00233.las	303,364,114	102,206,992	2.968/0.276	0.580/1.903
CS_00234.las	295,122,443	103,845,680	2.842/0.264	0.593/1.946
CS_00235.las	310,316,127	101,671,216	3.052/0.284	0.572/1.877
CS_00236.las	292,974,804	102,969,440	2.845/0.264	0.593/1.946
CS_00237.las	293,620,737	104,031,488	2.822/0.262	0.595/1.952
CS_00238.las	279,959,237	103,282,432	2.711/0.252	0.607/1.991
CS_00239.las	321,408,651	101,821,808	3.157/0.293	0.563/1.847

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File	Number of First Returns	Area	Point Density	NPS
CS_00240.las	297,541,036	103,681,312	2.870/0.267	0.590/1.936
CS_00241.las	303,465,100	103,208,160	2.940/0.273	0.583/1.913
CS_00242.las	295,867,089	101,534,080	2.914/0.271	0.586/1.923
CS_00243.las	267,744,729	96,771,360	2.767/0.257	0.601/1.972
CS_00244.las	298,151,772	102,205,168	2.917/0.271	0.585/1.919
CS_00245.las	104,708,761	35,320,816	2.965/0.275	0.581/1.906
CS_00246.las	332,256,463	103,381,728	3.214/0.299	0.558/1.831
CS_00247.las	460,204,241	101,469,056	4.535/0.421	0.470/1.542
CS_00248.las	295,564,919	102,010,160	2.897/0.269	0.587/1.926
CS_00249.las	304,673,704	101,967,120	2.988/0.278	0.579/1.900
CS_00250.las	297,657,401	103,830,752	2.867/0.266	0.591/1.939
CS_00251.las	283,541,241	103,486,608	2.740/0.255	0.604/1.982
CS_00252.las	443,743,716	103,453,856	4.289/0.398	0.483/1.585
CS_00253.las	393,053,932	102,984,736	3.817/0.355	0.512/1.680
CS_00254.las	397,960,302	102,743,680	3.873/0.360	0.508/1.667
CS_00255.las	350,967,656	103,022,928	3.407/0.317	0.542/1.778
CS_00256.las	343,719,490	102,753,936	3.345/0.311	0.547/1.795
CS_00257.las	342,514,403	102,431,440	3.344/0.311	0.547/1.795
CS_00258.las	339,013,138	102,768,368	3.299/0.306	0.551/1.808
CS_00259.las	356,810,935	103,057,072	3.462/0.322	0.537/1.762
CS_00260.las	333,135,296	102,649,952	3.245/0.301	0.555/1.821
CS_00261.las	353,710,104	102,874,000	3.438/0.319	0.539/1.768
CS_00262.las	329,725,297	103,867,360	3.174/0.295	0.561/1.841
CS_00263.las	380,239,855	103,908,384	3.659/0.340	0.523/1.716
CS_00264.las	366,393,770	104,084,336	3.520/0.327	0.533/1.749
CS_00265.las	348,743,784	102,949,184	3.388/0.315	0.543/1.781
CS_00266.las	337,521,454	103,807,552	3.251/0.302	0.555/1.821
CS_00267.las	362,201,242	103,488,464	3.500/0.325	0.535/1.755
CS_00268.las	360,820,576	102,783,680	3.510/0.326	0.534/1.752
CS_00269.las	356,448,426	103,973,792	3.428/0.318	0.540/1.772
CS_00270.las	287,309,963	99,974,752	2.874/0.267	0.590/1.936
CS_00271.las	293,520,607	102,920,352	2.852/0.265	0.592/1.942
CS_00272.las	274,402,015	97,719,632	2.808/0.261	0.597/1.959

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File	Number of First Returns	Area	Point Density	NPS
CS_00273.las	259,950,907	92,526,720	2.809/0.261	0.597/1.959
CS_00274.las	269,397,994	96,445,920	2.793/0.259	0.598/1.962
CS_00275.las	242,740,629	86,635,360	2.802/0.260	0.597/1.959
CS_00276.las	221,389,539	79,365,360	2.789/0.259	0.599/1.965
CS_00277.las	195,809,716	70,813,536	2.765/0.257	0.601/1.972
CS_00278.las	55,077,901	17,550,384	3.138/0.292	0.564/1.850
CS_00279.las	138,313,662	44,545,248	3.105/0.288	0.568/1.864
CS_00280.las	162,164,314	44,716,256	3.627/0.337	0.525/1.722
CS_00281.las	140,512,340	44,467,232	3.160/0.294	0.563/1.847
CS_00282.las	162,266,544	44,651,984	3.634/0.338	0.525/1.722
CS_00283.las	142,392,351	44,575,184	3.194/0.297	0.560/1.837
CS_00284.las	162,944,046	44,588,176	3.654/0.339	0.523/1.716
CS_00285.las	142,187,340	44,517,520	3.194/0.297	0.560/1.837
CS_00286.las	159,671,420	44,738,992	3.569/0.332	0.529/1.736
CS_00287.las	139,689,056	42,528,400	3.285/0.305	0.552/1.811
CS_00288.las	150,441,997	42,275,536	3.559/0.331	0.530/1.739
CS_00289.las	139,115,532	42,299,056	3.289/0.306	0.551/1.808
CS_00290.las	149,617,997	42,274,400	3.539/0.329	0.532/1.745
CS_00291.las	137,101,990	42,371,200	3.236/0.301	0.556/1.824
CS_00292.las	150,303,997	41,378,512	3.632/0.337	0.525/1.722
CS_00293.las	106,527,357	34,505,984	3.087/0.287	0.569/1.867
CS_00294.las	349,303,136	100,972,272	3.459/0.321	0.538/1.765
CS_00295.las	15,902,382	2,490,240	6.386/0.593	0.396/1.299
CS_00296.las	383,155,810	101,282,800	3.783/0.351	0.514/1.686
CS_00297.las	182,646,580	48,643,872	3.755/0.349	0.516/1.693
CS_00298.las	228,311,199	56,599,968	4.034/0.375	0.498/1.634
CS_00299.las	380,988,849	100,990,576	3.773/0.351	0.515/1.690
CS_00300.las	372,525,492	100,867,280	3.693/0.343	0.520/1.706
CS_00301.las	400,886,152	101,372,304	3.955/0.367	0.503/1.650
CS_00302.las	217,167,554	59,895,312	3.626/0.337	0.525/1.722
CS_00303.las	175,183,969	53,583,904	3.269/0.304	0.553/1.814
CS_00304.las	173,977,660	49,041,584	3.548/0.330	0.531/1.742
CS_00305.las	144,378,306	45,005,008	3.208/0.298	0.558/1.831

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

File	Number of First Returns	Area	Point Density	NPS
CS_00306.las	150,069,999	44,585,968	3.366/0.313	0.545/1.788
CS_00307.las	138,416,176	42,213,744	3.279/0.305	0.552/1.811
CS_00308.las	148,130,335	42,282,064	3.503/0.325	0.534/1.752
CS_00309.las	150,764,488	43,686,512	3.451/0.321	0.538/1.765
CS_00310.las	136,660,194	42,088,992	3.247/0.302	0.555/1.821
CS_00311.las	151,865,051	43,263,152	3.510/0.326	0.534/1.752
CS_00312.las	142,888,737	44,655,648	3.200/0.297	0.559/1.834
CS_00313.las	159,166,140	44,617,584	3.567/0.331	0.529/1.736
CS_00314.las	143,025,562	44,701,728	3.200/0.297	0.559/1.834
CS_00315.las	159,873,407	44,605,280	3.584/0.333	0.528/1.732
CS_00316.las	43,796,489	12,598,304	3.476/0.323	0.536/1.759
Average			3.218/0.299	0.557/1.827
			pp Square Meter/ pp Square US Survey Foot	Meter/ US Survey Feet
Lot_8	32,702,534,443	7,718,884,823	4.237/0.394	0.486/1.594
Aggregate	32,702,534,443	7,718,884,823	4.237/0.394	0.486/1.594
			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.