

C-4 Report on Nominal Pulse Spacing (NPS)

The USGS Lidar Base Specification 2023 rev. A states: "The required ANPS and ANPD by QL are listed in table 1. Aggregate Nominal Pulse Density (ANPD) and Aggregate Nominal Pulse Spacing (ANPS) shall meet the requirements of the Quality Level (QL) of the project with a minimum of QL2 for 3DEP collections. Aggregate Nominal Pulse Density (ANPD) shall be no less than 2 points per square meter (QL2); assessment to be made against single swath, first return data located within the geometrically usable center portion (typically ~95%) of each swath. Aggregate Nominal Pulse Spacing (ANPS) shall be no greater than 0.70 meters (QL2); assessment to be made against single swath, first return data located within the geometrically usable center portion (typically ~95%) of each swath. 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; ≤, less than or equal to; ≥, 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. Any 'Exclusion Shapefile' pathed out on the Input Tab of this tool was applied to the processing for this test to avoid skewing the results with known areas of no data.

[Data Source - D:\00 MNWest\B3 Swath Data](#)

Quality level tested: QL1

File	Number of First Returns	Area	Point Density	NPS
CS_00261.las	386,856,448	22,331,119	17.324/1.609	0.240/0.787
CS_00262.las	2,301,771,427	136,478,235	16.865/1.567	0.244/0.801
CS_00263.las	2,438,202,015	136,732,159	17.832/1.657	0.237/0.778
CS_00264.las	2,315,755,118	137,469,451	16.846/1.565	0.244/0.801
CS_00265.las	2,507,986,370	138,588,531	18.097/1.681	0.235/0.771

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File	Number of First Returns	Area	Point Density	NPS
CS_00266.las	2,454,139,669	138,671,492	17.698/1.644	0.238/0.781
CS_00267.las	1,383,187,153	78,932,016	17.524/1.628	0.239/0.784
CS_00268.las	62,269,128	3,883,022	16.036/1.490	0.250/0.820
CS_00269.las	1,139,979,022	64,869,212	17.573/1.633	0.239/0.784
CS_00285.las	68,831,170	5,738,884	11.994/1.114	0.289/0.948
CS_00289.las	31,643,769	2,013,559	15.715/1.460	0.252/0.827
CS_00290.las	283,381,565	17,490,137	16.202/1.505	0.248/0.814
CS_00292.las	653,394,347	40,075,029	16.304/1.515	0.248/0.814
CS_00293.las	1,171,717,747	63,923,169	18.330/1.703	0.234/0.768
CS_00295.las	1,603,855,681	90,776,735	17.668/1.641	0.238/0.781
CS_00296.las	2,115,541,382	119,098,123	17.763/1.650	0.237/0.778
CS_00297.las	2,359,712,064	134,688,137	17.520/1.628	0.239/0.784
CS_00298.las	2,361,332,236	135,538,086	17.422/1.619	0.240/0.787
CS_00299.las	2,584,153,925	141,474,581	18.266/1.697	0.234/0.768
CS_00300.las	1,362,935,345	78,930,929	17.267/1.604	0.241/0.791
CS_00301.las	230,525,832	12,929,431	17.830/1.656	0.237/0.778
CS_00302.las	1,120,226,349	63,685,500	17.590/1.634	0.238/0.781
CS_00303.las	2,546,987,862	143,424,999	17.758/1.650	0.237/0.778
CS_00304.las	919,570,731	52,939,650	17.370/1.614	0.240/0.787
CS_00305.las	98,186,370	5,431,686	18.077/1.679	0.235/0.771
CS_00306.las	1,655,233,193	92,535,706	17.888/1.662	0.236/0.774
CS_00307.las	2,465,951,147	140,850,981	17.508/1.627	0.239/0.784
CS_00308.las	1,976,868,406	115,275,020	17.149/1.593	0.241/0.791
CS_00309.las	1,584,761,733	103,400,993	15.326/1.424	0.255/0.837
CS_00310.las	2,331,105,282	134,563,842	17.323/1.609	0.240/0.787
CS_00311.las	2,416,362,780	134,596,164	17.953/1.668	0.236/0.774
CS_00312.las	2,313,839,413	134,710,987	17.176/1.596	0.241/0.791
CS_00313.las	2,398,453,460	134,617,642	17.817/1.655	0.237/0.778
CS_00314.las	2,317,116,888	133,320,372	17.380/1.615	0.240/0.787
CS_00315.las	2,398,921,442	135,693,024	17.679/1.642	0.238/0.781
CS_00316.las	37,121,459	2,138,836	17.356/1.612	0.240/0.787
CS_00317.las	2,331,823,102	135,947,455	17.152/1.593	0.241/0.791
CS_00318.las	252,653,853	14,262,872	17.714/1.646	0.238/0.781

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File	Number of First Returns	Area	Point Density	NPS
CS_00319.las	536,368,350	29,103,249	18.430/1.712	0.233/0.764
CS_00320.las	85,931,335	4,531,816	18.962/1.762	0.230/0.755
CS_00321.las	1,105,624,692	66,981,294	16.506/1.533	0.246/0.807
CS_00322.las	166,834,596	9,629,843	17.325/1.610	0.240/0.787
CS_00323.las	322,667,467	18,747,487	17.211/1.599	0.241/0.791
CS_00324.las	184,319,212	10,594,832	17.397/1.616	0.240/0.787
CS_00325.las	1,219,903,284	74,799,984	16.309/1.515	0.248/0.814
CS_00326.las	1,610,871,109	93,341,839	17.258/1.603	0.241/0.791
CS_00327.las	1,589,673,447	93,122,822	17.071/1.586	0.242/0.794
CS_00328.las	1,593,311,022	93,035,052	17.126/1.591	0.242/0.794
CS_00329.las	102,858,021	6,182,632	16.637/1.546	0.245/0.804
CS_00330.las	222,661,293	12,773,387	17.432/1.619	0.240/0.787
CS_00331.las	375,856,684	20,951,860	17.939/1.667	0.236/0.774
CS_00332.las	212,471,355	11,948,169	17.783/1.652	0.237/0.778
CS_00333.las	1,274,073,808	74,541,150	17.092/1.588	0.242/0.794
CS_00334.las	198,796,563	11,017,347	18.044/1.676	0.235/0.771
CS_00335.las	1,609,506,018	93,177,324	17.274/1.605	0.241/0.791
CS_00336.las	1,643,341,503	93,111,741	17.649/1.640	0.238/0.781
CS_00337.las	1,627,592,356	93,173,246	17.468/1.623	0.239/0.784
CS_00338.las	1,624,487,405	93,208,239	17.429/1.619	0.240/0.787
CS_00339.las	1,636,827,836	93,260,089	17.551/1.631	0.239/0.784
CS_00340.las	1,609,182,530	93,207,260	17.265/1.604	0.241/0.791
CS_00341.las	1,590,963,240	93,203,157	17.070/1.586	0.242/0.794
CS_00342.las	1,598,505,325	93,140,334	17.162/1.594	0.241/0.791
CS_00343.las	1,610,753,611	93,041,361	17.312/1.608	0.240/0.787
CS_00344.las	145,273,441	8,199,841	17.717/1.646	0.238/0.781
CS_00346.las	1,624,964,019	92,869,086	17.497/1.626	0.239/0.784
CS_00347.las	1,566,315,198	92,987,990	16.844/1.565	0.244/0.801
CS_00348.las	1,560,295,438	92,792,094	16.815/1.562	0.244/0.801
CS_00349.las	123,334,690	6,761,622	18.240/1.695	0.234/0.768
CS_00350.las	1,653,820,226	93,060,727	17.771/1.651	0.237/0.778
CS_00351.las	1,556,337,437	93,059,277	16.724/1.554	0.245/0.804
CS_00352.las	1,632,496,802	92,224,767	17.701/1.644	0.238/0.781

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File	Number of First Returns	Area	Point Density	NPS
CS_00353.las	1,144,479,908	68,725,530	16.653/1.547	0.245/0.804
CS_00354.las	8,861,992	211,649	41.871/3.890	0.155/0.509
CS_00380.las	333,437,795	17,556,798	18.992/1.764	0.229/0.751
CS_00381.las	150,353,926	8,741,001	17.201/1.598	0.241/0.791
CS_00382.las	72,474,916	4,106,265	17.650/1.640	0.238/0.781
CS_00383.las	162,180,078	8,091,170	20.044/1.862	0.223/0.732
CS_00397.las	367,215,385	19,946,388	18.410/1.710	0.233/0.764
CS_00398.las	110,674,657	8,642,622	12.806/1.190	0.279/0.915
CS_00399.las	167,077,737	8,839,521	18.901/1.756	0.230/0.755
CS_00400.las	139,219,079	7,104,663	19.595/1.820	0.226/0.741
CS_00427.las	187,520,243	9,207,526	20.366/1.892	0.222/0.728
CS_00428.las	1,368,866,678	72,551,080	18.868/1.753	0.230/0.755
CS_00429.las	256,775,251	15,070,652	17.038/1.583	0.242/0.794
CS_00430.las	420,166,389	21,319,614	19.708/1.831	0.225/0.738
Average			17.517/1.627	0.239/0.784
			pp Square Meter/ pp Square US Survey Foot	Meter/ US Survey Feet
1607.73	99,087,556,871	4,164,000,000	23.796/2.211	0.205/0.673
Aggregate	99,087,556,871	4,164,000,000	23.796/2.211	0.205/0.673
			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.