

## C-4 Report on Nominal Pulse Spacing (NPS)

The USGS Lidar Base Specification 2022 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/m<sup>2</sup>, 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 <sup>2</sup> )
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 - V:\Mapping\Projects\65221205\\_IL\\_MidNorth\Production\Final\\_Client\\_Deliverables\229058\IL\\_MidNorth\\_1\\_D22\\_229055\point\\_cloud\Swaths](V:\Mapping\Projects\65221205_IL_MidNorth\Production\Final_Client_Deliverables\229058\IL_MidNorth_1_D22_229055\point_cloud\Swaths)

Quality level tested: QL2

File	Number of First Returns	Area	Point Density	NPS
CS_01001.las	393,207,838	749,043,363	5.651/0.525	0.421/1.380
CS_01002.las	1,946,371	3,503,363	5.985/0.556	0.409/1.342
CS_01003.las	22,173,385	41,427,662	5.759/0.535	0.417/1.367
CS_01004.las	317,000,318	591,460,856	5.769/0.536	0.416/1.366

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File	Number of First Returns	Area	Point Density	NPS
CS_01005.las	710,755,474	1,096,146,111	6.975/0.648	0.379/1.242
CS_01006.las	1,263,002,325	2,440,932,486	5.565/0.517	0.424/1.390
CS_01008.las	58,861,620	172,252,179	3.681/0.342	0.522/1.711
CS_01009.las	1,260,145,501	2,542,805,773	5.339/0.496	0.433/1.421
CS_01010.las	382,941,849	596,438,536	6.910/0.642	0.380/1.248
CS_01011.las	1,550,796,847	2,762,039,680	6.039/0.561	0.407/1.335
CS_01013.las	1,661,142,083	2,761,899,609	6.469/0.601	0.393/1.289
CS_01016.las	749,709,784	1,464,002,346	5.511/0.512	0.426/1.397
CS_01017.las	1,797,125,759	2,510,829,214	7.707/0.716	0.360/1.182
CS_01018.las	10,198,296	30,484,542	3.606/0.335	0.527/1.729
CS_01021.las	31,060,981	56,648,535	5.899/0.548	0.411/1.350
CS_01022.las	2,095,822,533	2,753,539,009	8.191/0.761	0.349/1.146
CS_01023.las	753,148,712	1,479,990,208	5.479/0.509	0.427/1.402
CS_01024.las	186,063,974	318,169,508	6.297/0.585	0.399/1.308
CS_01026.las	54,177,941	83,250,989	7.007/0.651	0.378/1.240
CS_01027.las	1,485,848,936	2,761,086,558	5.791/0.538	0.415/1.363
CS_01028.las	96,275,193	154,907,114	6.695/0.622	0.386/1.268
CS_01030.las	1,723,445,024	2,776,277,506	6.684/0.621	0.387/1.269
CS_01032.las	516,941,658	844,367,547	6.588/0.612	0.390/1.278
CS_01033.las	1,028,747,488	2,015,862,010	5.490/0.510	0.427/1.400
CS_01034.las	1,152,434,487	2,180,080,784	5.694/0.529	0.419/1.375
CS_01035.las	304,835,149	655,533,685	5.005/0.465	0.447/1.466
CS_01036.las	1,529,728,563	2,542,556,519	6.480/0.602	0.393/1.289
CS_01037.las	438,027,623	843,615,144	5.586/0.519	0.423/1.388
CS_01038.las	1,122,938,301	1,692,284,574	7.147/0.664	0.374/1.228
CS_01039.las	291,287,749	574,872,543	5.457/0.507	0.428/1.405
CS_01041.las	130,077,211	215,254,583	6.501/0.604	0.392/1.286
CS_01042.las	95,686,633	143,814,485	7.158/0.665	0.374/1.226
CS_01043.las	94,278,882	155,252,751	6.534/0.607	0.391/1.283
CS_01044.las	1,167,901,233	1,512,787,529	8.310/0.772	0.347/1.138
CS_01045.las	1,551,739,398	2,547,138,982	6.555/0.609	0.390/1.281
CS_01047.las	434,600,810	745,778,205	6.275/0.583	0.399/1.310
CS_01048.las	108,426,347	264,204,366	4.413/0.410	0.476/1.561

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File	Number of First Returns	Area	Point Density	NPS
CS_01049.las	1,553,943,009	2,854,425,695	5.856/0.544	0.413/1.355
CS_01050.las	52,615,479	86,280,627	6.566/0.610	0.390/1.281
CS_01051.las	1,512,654,987	2,318,005,499	7.029/0.653	0.377/1.238
CS_01053.las	1,494,720,934	2,516,852,358	6.394/0.594	0.396/1.298
CS_01054.las	502,066,894	703,433,803	7.685/0.714	0.361/1.184
CS_01055.las	1,445,116,750	2,542,087,522	6.114/0.568	0.404/1.326
CS_01057.las	300,120,730	501,528,030	6.437/0.598	0.394/1.293
CS_01058.las	1,502,056,640	2,514,558,798	6.426/0.597	0.394/1.294
CS_01059.las	1,723,527,185	2,513,456,230	7.384/0.686	0.368/1.208
CS_01060.las	607,571,788	930,529,198	7.029/0.653	0.377/1.238
CS_01061.las	1,594,788,981	2,892,743,165	5.931/0.551	0.411/1.347
CS_01063.las	233,262,835	545,670,300	4.596/0.427	0.466/1.529
CS_01065.las	722,564,116	1,467,136,662	5.296/0.492	0.434/1.425
CS_01068.las	1,496,741,677	2,761,315,662	5.834/0.542	0.414/1.358
CS_01069.las	1,944,742,476	2,753,902,253	7.599/0.706	0.363/1.190
CS_01070.las	1,517,847,429	2,522,398,052	6.480/0.602	0.393/1.289
CS_01071.las	148,573,780	224,137,489	7.136/0.663	0.374/1.228
CS_01073.las	1,507,212,026	2,757,205,713	5.888/0.547	0.412/1.353
CS_01074.las	90,538,217	139,180,564	7.007/0.651	0.378/1.240
CS_01075.las	269,032,343	463,029,890	6.254/0.581	0.400/1.312
CS_01076.las	1,606,654,511	2,761,494,743	6.265/0.582	0.400/1.311
CS_01078.las	174,640,317	386,123,080	4.865/0.452	0.453/1.487
CS_01079.las	2,011,061,151	2,753,022,722	7.858/0.730	0.357/1.170
CS_01081.las	1,466,239,278	2,593,884,551	6.082/0.565	0.405/1.330
CS_01082.las	1,479,283,788	2,531,648,424	6.286/0.584	0.399/1.308
CS_01083.las	1,485,769,623	2,541,240,957	6.297/0.585	0.399/1.308
CS_01086.las	546,595,753	763,874,762	7.707/0.716	0.360/1.182
CS_01087.las	1,186,003,129	1,769,156,626	7.212/0.670	0.372/1.221
CS_01094.las	118,820,491	201,920,415	6.329/0.588	0.397/1.304
CS_01095.las	1,577,031,508	2,759,770,886	6.146/0.571	0.403/1.323
CS_01096.las	571,720,219	994,440,423	6.189/0.575	0.402/1.319
CS_01097.las	154,678,094	257,297,937	6.469/0.601	0.393/1.290
CS_01098.las	1,449,279,815	2,763,828,263	5.640/0.524	0.421/1.381

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File	Number of First Returns	Area	Point Density	NPS
CS_01099.las	97,196,522	163,548,391	6.394/0.594	0.395/1.297
CS_01100.las	1,606,561,626	2,765,853,665	6.254/0.581	0.400/1.312
CS_01101.las	1,670,715,641	2,765,047,602	6.501/0.604	0.392/1.286
CS_01102.las	1,626,999,730	2,760,670,783	6.340/0.589	0.397/1.303
CS_01103.las	1,631,641,581	2,759,710,198	6.361/0.591	0.397/1.301
CS_01104.las	1,066,664,119	1,809,518,515	6.340/0.589	0.397/1.302
CS_01105.las	1,504,484,659	2,741,740,311	5.909/0.549	0.411/1.350
CS_01106.las	1,705,345,184	2,759,993,232	6.652/0.618	0.388/1.272
CS_01107.las	1,311,634,905	2,555,033,507	5.522/0.513	0.426/1.396
Average			6.168/0.573	0.403/1.321
			<small>pp Square Meter/ pp Square US Survey Foot</small>	<small>Meter/ US Survey Feet</small>
229055	72,839,203,766	95,060,000,000	8.245/0.766	0.348/1.142
Aggregate	72,839,203,766	95,060,000,000	8.245/0.766	0.348/1.142
			<small>pp Square Meter/ pp Square US Survey Foot</small>	<small>Meter/ US Survey Feet</small>

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