

## C-2 Report on Multiple Discrete Returns

The USGS Lidar Base Specification 2022 rev. A states: "Deriving and delivering multiple discrete returns are required in all conventional lidar data collection efforts. Data collection shall be capable of at least three returns per pulse."

The purpose of this section is to report on the presence and quantities of lidar returns in the LAS data. Empty return columns can indicate a collection or processing problem dealing with lidar return attribute information.

[Data Source - V:\Mapping\Projects\65221273\\_MN\\_UpperMSRiver\Production\Final\\_Client\\_Deliverables\230958\MN\\_UpperMSRiver\\_2\\_B22\\_300138\point\\_cloud\Swaths\Restored](V:\Mapping\Projects\65221273_MN_UpperMSRiver\Production\Final_Client_Deliverables\230958\MN_UpperMSRiver_2_B22_300138\point_cloud\Swaths\Restored)

File	First return	Second return	Third return	Other returns	Total points
CS_00001.las	62,905,453	28,495,511	8,197,638	1,224,556	100,823,158
CS_00025.las	850,897,252	369,011,697	135,059,075	28,608,912	1,383,576,936
CS_00026.las	620,312,679	301,091,762	100,012,799	19,258,915	1,040,676,155
CS_00027.las	828,176,117	394,401,191	128,911,355	25,964,704	1,377,453,367
CS_00028.las	822,246,194	391,665,767	140,244,910	30,319,034	1,384,475,905
CS_00029.las	295,400,354	142,170,559	48,202,293	10,080,251	495,853,457
CS_00030.las	866,626,722	402,700,983	150,522,574	32,764,999	1,452,615,278
CS_00031.las	79,345,017	30,987,392	11,383,208	2,550,097	124,265,714
CS_00032.las	57,047,487	19,440,357	6,157,744	1,112,221	83,757,809
CS_00127.las	39,351,999	25,088,257	9,678,266	1,880,521	75,999,043
CS_00128.las	35,794,627	24,696,283	10,094,162	2,178,913	72,763,985
CS_00129.las	2,062,444	1,329,858	422,579	66,780	3,881,661
CS_00197.las	79,444,976	34,649,138	14,693,147	4,023,815	132,811,076
CS_00203.las	156,516,430	68,033,089	25,901,488	5,928,376	256,379,383
CS_00208.las	554,515,189	253,858,986	109,268,640	31,570,635	949,213,450
CS_00209.las	303,352,848	176,815,611	73,252,614	19,695,868	573,116,941
CS_00210.las	726,053,702	423,271,173	176,730,086	49,938,437	1,375,993,398
CS_00211.las	595,239,741	352,172,850	154,014,682	44,079,879	1,145,507,152
CS_00212.las	782,897,395	389,527,687	169,345,935	47,411,488	1,389,182,505
CS_00213.las	612,065,380	361,798,852	153,373,316	43,515,216	1,170,752,764
CS_00214.las	747,346,382	421,896,620	169,163,899	47,075,338	1,385,482,239
CS_00215.las	527,544,417	312,458,672	141,017,738	42,794,723	1,023,815,550
CS_00216.las	37,797,873	8,121,765	3,126,752	746,167	49,792,557
CS_00236.las	143,076,144	72,087,292	30,222,712	8,168,997	253,555,145
CS_00237.las	746,270,822	402,567,335	188,974,611	60,713,142	1,398,525,910
CS_00238.las	555,653,833	310,070,277	126,580,096	35,361,731	1,027,665,937

## *C-2 Report on Multiple Discrete Returns - continued*

File	First return	Second return	Third return	Other returns	Total points
CS_00239.las	188,552,078	115,263,047	49,571,946	14,562,793	367,949,864
CS_00240.las	715,221,014	425,981,705	181,077,623	53,321,854	1,375,602,196
CS_00241.las	490,112,696	297,247,894	137,315,668	44,727,079	969,403,337
CS_00242.las	189,564,709	122,455,237	57,084,155	18,966,314	388,070,415
CS_00243.las	771,824,399	443,080,311	193,087,914	57,899,923	1,465,892,547
CS_00244.las	466,773,006	215,497,494	97,459,530	29,929,055	809,659,085
CS_00245.las	786,957,942	377,940,641	168,138,759	51,495,929	1,384,533,271
CS_00246.las	589,259,216	349,504,258	150,213,774	43,560,314	1,132,537,562
CS_00247.las	709,574,298	433,569,531	189,398,138	56,371,586	1,388,913,553
CS_00248.las	604,622,343	376,729,855	178,647,143	59,375,552	1,219,374,893
CS_00249.las	69,069,017	32,489,062	14,715,006	4,217,972	120,491,057
CS_00250.las	63,332,140	28,795,522	12,630,800	3,481,349	108,239,811
CS_00251.las	252,822,772	133,192,727	57,194,717	16,176,982	459,387,198
CS_00252.las	767,230,230	387,287,017	178,391,665	56,169,076	1,389,077,988
CS_00253.las	697,361,580	394,070,733	164,146,420	45,863,079	1,301,441,812
CS_00254.las	134,530,319	72,402,101	31,762,032	9,824,973	248,519,425
CS_00255.las	723,925,768	454,043,047	215,333,775	72,477,641	1,465,780,231
CS_00256.las	542,320,669	319,556,466	139,298,647	41,728,582	1,042,904,364
CS_00257.las	159,844,227	95,323,790	45,042,562	15,750,433	315,961,012
CS_00258.las	727,316,420	445,101,751	198,225,630	61,081,894	1,431,725,695
CS_00259.las	620,453,263	374,007,385	178,211,819	60,688,685	1,233,361,152
CS_00260.las	788,219,278	362,891,158	171,211,438	56,192,367	1,378,514,241
CS_00261.las	730,560,356	434,066,865	189,626,590	56,369,698	1,410,623,509
CS_00262.las	698,162,374	421,741,232	179,554,942	50,697,252	1,350,155,800
CS_00263.las	712,084,840	425,477,662	196,146,807	63,854,940	1,397,564,249
CS_00264.las	804,895,345	372,100,012	165,761,855	50,305,077	1,393,062,289
CS_00265.las	766,332,111	451,355,272	193,170,713	54,533,831	1,465,391,927
CS_00266.las	373,232,971	213,782,186	100,340,026	33,093,929	720,449,112
CS_00267.las	84,258,597	48,639,333	20,992,302	6,031,463	159,921,695
CS_00268.las	13,236,123	7,700,341	3,160,745	833,220	24,930,429
CS_00269.las	761,855,555	453,869,523	194,038,855	55,335,194	1,465,099,127
CS_00270.las	143,037,995	92,945,220	43,534,635	14,191,289	293,709,139
CS_00271.las	705,181,837	432,270,910	180,374,518	50,062,014	1,367,889,279
CS_00272.las	684,287,069	404,313,001	187,179,536	59,938,114	1,335,717,720

## *C-2 Report on Multiple Discrete Returns - continued*

File	First return	Second return	Third return	Other returns	Total points
CS_00301.las	743,084,915	450,993,170	206,070,042	65,880,284	1,466,028,411
CS_00302.las	497,099,915	271,137,305	103,396,121	26,785,996	898,419,337
CS_00303.las	187,574,625	104,502,707	45,082,885	13,888,101	351,048,318
CS_00304.las	725,487,413	454,445,436	214,358,984	71,468,035	1,465,759,868
CS_00305.las	574,201,499	344,075,558	149,554,388	45,328,165	1,113,159,610
CS_00306.las	761,253,255	449,772,374	196,961,319	57,789,543	1,465,776,491
CS_00307.las	618,715,080	311,325,192	143,207,194	45,647,494	1,118,894,960
CS_00308.las	753,594,486	453,112,152	198,985,206	60,111,027	1,465,802,871
CS_00309.las	692,361,695	333,041,783	157,650,594	51,420,247	1,234,474,319
CS_00310.las	721,878,455	455,094,007	215,792,357	72,647,611	1,465,412,430
CS_00311.las	477,917,164	276,793,110	119,239,622	34,509,867	908,459,763
CS_00312.las	769,399,363	448,358,252	192,746,221	55,097,024	1,465,600,860
CS_00313.las	753,706,956	314,958,664	142,862,042	44,660,705	1,256,188,367
CS_00314.las	720,940,079	449,838,100	215,033,866	79,142,377	1,464,954,422
CS_00315.las	609,859,524	304,108,182	152,387,489	58,130,735	1,124,485,930
CS_00319.las	52,661,054	17,733,925	7,105,166	1,760,468	79,260,613
CS_00320.las	354,947,502	209,079,695	90,752,206	26,222,020	681,001,423
CS_00321.las	278,006,121	164,710,066	64,448,644	16,332,945	523,497,776
CS_00322.las	758,832,681	454,697,144	195,909,434	56,024,322	1,465,463,581
CS_00323.las	695,149,696	323,352,843	142,216,020	40,612,814	1,201,331,373
CS_00324.las	761,006,220	443,881,175	199,320,145	61,047,595	1,465,255,135
CS_00325.las	401,139,544	224,487,451	83,944,120	20,478,888	730,050,003
CS_00326.las	782,787,358	445,112,933	185,425,334	51,571,825	1,464,897,450
CS_00327.las	616,366,868	298,774,739	135,563,782	41,158,830	1,091,864,219
CS_00354.las	851,170,368	422,351,169	156,329,671	35,232,933	1,465,084,141
CS_00355.las	705,564,453	324,921,452	104,473,806	20,490,201	1,155,449,912
CS_00356.las	401,748,813	194,527,309	81,068,299	21,976,472	699,320,893
CS_00357.las	352,643,227	188,324,953	80,567,768	22,608,882	644,144,830
CS_00358.las	844,317,668	354,686,344	149,998,224	41,650,884	1,390,653,120
CS_00359.las	759,472,392	452,222,103	197,760,057	56,162,706	1,465,617,258
CS_00360.las	32,134,396	19,513,730	9,167,020	3,031,032	63,846,178
CS_00361.las	230,381,601	135,752,270	57,417,153	16,097,917	439,648,941
CS_00362.las	581,333,363	360,715,763	162,388,717	47,747,872	1,152,185,715
CS_00363.las	120,969,024	61,313,143	26,427,691	7,488,794	216,198,652

## *C-2 Report on Multiple Discrete Returns - continued*

File	First return	Second return	Third return	Other returns	Total points
CS_00364.las	777,435,841	455,554,979	183,675,904	48,895,431	1,465,562,155
CS_00365.las	24,780,469	16,987,309	7,366,698	1,902,725	51,037,201
CS_00366.las	91,120,084	59,623,104	24,698,762	6,106,033	181,547,983
CS_00367.las	752,442,210	422,384,937	164,895,434	40,797,407	1,380,519,988
CS_00368.las	602,797,334	364,475,657	157,685,731	42,392,643	1,167,351,365
CS_00369.las	886,900,051	329,841,133	138,173,331	37,534,510	1,392,449,025
CS_00370.las	702,415,013	405,164,579	176,736,397	50,231,505	1,334,547,494
CS_00371.las	702,558,743	431,804,949	182,676,161	50,643,721	1,367,683,574
CS_00372.las	737,078,828	445,026,730	196,017,285	55,705,289	1,433,828,132
CS_00373.las	867,502,410	332,624,811	146,704,710	42,199,552	1,389,031,483
CS_00374.las	773,846,009	431,983,411	198,841,171	60,852,388	1,465,522,979
CS_00375.las	324,490,716	207,497,691	91,501,716	25,823,343	649,313,466
CS_00376.las	765,133,796	445,559,357	197,222,810	57,961,504	1,465,877,467
CS_00377.las	924,987,072	335,694,295	141,182,391	38,609,791	1,440,473,549
CS_00379.las	768,048,597	451,434,926	194,061,553	52,390,716	1,465,935,792
CS_00380.las	436,591,457	253,624,520	102,091,847	26,028,718	818,336,542
CS_00381.las	808,771,467	412,879,292	187,275,024	56,627,606	1,465,553,389
CS_00382.las	770,400,059	307,029,881	132,868,160	37,852,931	1,248,151,031
CS_00383.las	108,419,073	31,524,499	11,833,807	2,584,120	154,361,499
CS_00384.las	242,294,697	122,250,597	49,358,838	12,294,333	426,198,465
CS_00385.las	777,322,467	400,262,468	164,505,854	41,838,285	1,383,929,074
CS_00386.las	773,647,343	458,844,418	186,252,429	46,951,934	1,465,696,124
CS_00387.las	30,121,204	19,649,219	8,052,553	1,956,257	59,779,233
CS_00388.las	248,031,483	136,107,088	53,484,655	12,931,413	450,554,639
CS_00389.las	763,070,489	462,837,710	190,571,512	49,096,790	1,465,576,501
CS_00390.las	476,724,557	288,747,348	114,830,694	28,428,997	908,731,596
CS_00391.las	92,711,131	56,648,619	24,502,026	6,869,457	180,731,233
CS_00392.las	730,522,558	437,694,930	168,477,449	39,656,888	1,376,351,825
CS_00393.las	103,362,762	61,007,327	24,781,411	6,177,220	195,328,720
CS_00394.las	131,757,384	64,147,180	25,356,590	6,061,742	227,322,896
CS_00395.las	417,582,542	262,192,881	114,736,689	31,964,029	826,476,141
CS_00396.las	783,153,298	449,533,111	185,699,816	47,225,397	1,465,611,622
CS_00397.las	824,407,714	417,118,909	176,364,109	47,525,463	1,465,416,195
CS_00398.las	20,898,564	10,721,470	4,135,167	919,021	36,674,222

## *C-2 Report on Multiple Discrete Returns - continued*

<u>File</u>	<u>First return</u>	<u>Second return</u>	<u>Third return</u>	<u>Other returns</u>	<u>Total points</u>
CS_00399.las	829,205,847	364,943,627	156,056,577	43,049,108	1,393,255,159
CS_00400.las	598,717,417	323,457,621	133,507,947	33,999,433	1,089,682,418
CS_00401.las	771,282,550	461,696,168	185,982,302	46,447,497	1,465,408,517
CS_00402.las	534,640,064	313,118,216	117,659,706	26,961,850	992,379,836
CS_00403.las	764,925,802	421,195,382	154,729,091	35,551,816	1,376,402,091
CS_00404.las	452,597,500	279,891,443	114,937,424	28,442,323	875,868,690
CS_00405.las	832,930,440	416,794,604	171,422,276	44,143,037	1,465,290,357
CS_00406.las	671,917,501	289,158,610	121,797,133	32,907,770	1,115,781,014
CS_00407.las	810,375,678	372,309,297	161,774,333	45,176,374	1,389,635,682
CS_00408.las	521,402,937	306,616,956	135,056,231	38,854,889	1,001,931,013
CS_00409.las	773,204,949	457,111,233	187,827,845	46,981,952	1,465,125,979
CS_00410.las	620,222,164	347,760,345	124,860,341	27,982,716	1,120,825,566
CS_00411.las	201,984,705	122,593,920	49,535,719	11,791,093	385,905,437
CS_00412.las	782,587,885	400,217,766	167,220,371	42,439,659	1,392,465,681
CS_00413.las	745,161,376	419,951,743	166,959,723	38,111,695	1,370,184,537
CS_00414.las	163,019,922	95,410,038	37,865,530	9,022,264	305,317,754
CS_00415.las	66,449,152	39,391,267	16,021,676	3,606,434	125,468,529
CS_00416.las	788,664,866	454,511,436	180,470,067	42,303,654	1,465,950,023
CS_00417.las	382,838,916	226,773,729	87,974,954	20,004,711	717,592,310
CS_00418.las	106,685,325	66,599,128	24,380,043	4,725,338	202,389,834
CS_00419.las	750,691,021	425,934,735	165,131,119	36,942,097	1,378,698,972
CS_00420.las	609,306,883	360,261,907	148,039,320	37,083,576	1,154,691,686
CS_00421.las	818,417,140	428,125,715	175,733,580	43,460,658	1,465,737,093
CS_00422.las	604,569,466	358,778,396	159,550,053	46,156,522	1,169,054,437
CS_00423.las	718,726,119	416,180,820	187,899,488	54,577,363	1,377,383,790
CS_00424.las	788,485,377	400,939,195	168,401,509	43,178,349	1,401,004,430
CS_00425.las	766,406,444	461,845,691	190,321,707	47,196,849	1,465,770,691
CS_00426.las	382,816,088	214,919,730	82,099,983	19,487,959	699,323,760
CS_00427.las	742,289,826	419,614,595	172,405,457	44,077,956	1,378,387,834
CS_00428.las	603,031,859	398,228,145	174,026,692	46,157,381	1,221,444,077
CS_00429.las	794,682,302	438,365,118	185,465,173	47,009,894	1,465,522,487
CS_00430.las	680,788,085	386,395,056	174,988,112	51,027,110	1,293,198,363
CS_00431.las	723,200,673	412,004,171	187,965,152	54,881,608	1,378,051,604
CS_00432.las	626,775,548	364,741,573	158,000,191	41,542,197	1,191,059,509

## *C-2 Report on Multiple Discrete Returns - continued*

File	First return	Second return	Third return	Other returns	Total points
CS_00433.las	22,868,743	15,068,008	7,033,858	1,991,529	46,962,138
CS_00434.las	692,613,947	438,560,488	194,934,306	53,116,174	1,379,224,915
CS_00435.las	452,438,078	273,340,841	114,768,406	30,520,425	871,067,750
CS_00436.las	704,039,188	427,654,211	188,091,437	53,584,236	1,373,369,072
CS_00437.las	303,624,398	199,084,828	92,599,497	29,380,773	624,689,496
CS_00438.las	453,896,387	247,357,960	102,306,846	23,996,905	827,558,098
CS_00439.las	639,449,072	347,164,703	157,989,333	45,718,165	1,190,321,273
CS_00500.las	135,219,661	60,909,836	24,431,815	6,518,465	227,079,777
CS_00501.las	798,698,843	386,872,056	162,207,514	44,869,311	1,392,647,724
CS_00502.las	691,515,039	357,597,046	137,063,815	35,105,868	1,221,281,768
CS_00503.las	137,984,365	81,963,358	35,008,133	10,286,308	265,242,164
CS_00504.las	784,494,995	433,757,587	188,208,811	56,773,485	1,463,234,878
CS_00505.las	544,518,042	283,926,600	106,452,421	27,193,386	962,090,449
CS_00506.las	457,721,761	268,772,876	114,336,109	32,907,900	873,738,646
CS_00508.las	727,618,768	419,589,838	166,415,560	43,029,048	1,356,653,214
CS_00509.las	331,573,945	186,067,769	74,931,784	18,966,107	611,539,605
CS_00510.las	98,421,218	62,837,842	27,007,555	7,586,799	195,853,414
CS_00511.las	156,020,149	91,479,877	36,379,593	9,339,224	293,218,843
CS_00513.las	736,520,403	410,189,227	169,220,097	47,113,708	1,363,043,435
CS_00514.las	271,699,292	157,982,602	66,363,326	18,411,520	514,456,740
CS_00530.las	295,851,345	162,981,124	70,242,940	20,179,003	549,254,412
CS_00531.las	1,399,499,419	606,983,088	255,885,138	69,533,609	2,331,901,254
CS_00532.las	1,474,463,165	864,517,588	352,065,440	90,365,911	2,781,412,104
CS_00533.las	1,087,180,661	647,396,323	268,713,103	72,164,741	2,075,454,828
CS_00534.las	168,712,214	97,537,535	41,374,677	11,959,503	319,583,929
CS_00535.las	27,028,879	17,957,705	8,264,908	2,488,396	55,739,888
CS_00540.las	47,829,477	27,999,769	12,236,601	3,481,207	91,547,054
CS_00541.las	1,045,497,172	518,170,534	223,545,536	62,865,246	1,850,078,488
CS_00542.las	37,684,162	22,641,763	9,373,439	2,743,702	72,443,066
CS_00543.las	939,655,679	538,945,329	225,052,753	63,610,802	1,767,264,563
CS_00544.las	79,889,009	46,624,465	19,193,598	5,080,290	150,787,362
CS_00545.las	1,118,634,782	631,246,707	258,972,742	71,175,721	2,080,029,952
CS_00546.las	83,237,036	52,849,227	22,595,808	6,321,054	165,003,125
CS_00547.las	918,051,594	403,622,357	161,785,520	41,394,054	1,524,853,525

*C-2 Report on Multiple Discrete Returns - continued*

<u>File</u>	<u>First return</u>	<u>Second return</u>	<u>Third return</u>	<u>Other returns</u>	<u>Total points</u>
CS_00548.las	228,936,911	119,524,804	50,567,796	13,877,909	412,907,420
CS_00549.las	145,024,116	63,027,340	25,281,969	6,349,947	239,683,372
CS_00550.las	61,045,911	14,923,221	5,615,127	1,316,036	82,900,295
CS_00551.las	320,227,684	162,814,430	60,072,294	14,303,664	557,418,072
CS_00552.las	318,762,342	175,052,528	66,642,277	16,110,829	576,567,976
CS_00555.las	3,014,198	2,161,355	1,063,373	334,764	6,573,690
CS_00556.las	11,016,873	3,679,487	1,354,227	301,374	16,351,961
CS_00560.las	15,053,650	6,165,751	2,062,711	453,456	23,735,568
CS_00569.las	393,515,000	202,275,454	79,157,017	19,485,999	694,433,470
CS_00570.las	507,889,835	278,474,071	108,328,924	27,546,626	922,239,456
CS_00577.las	40,421,332	8,090,969	2,903,867	650,740	52,066,908
CS_00614.las	50,763,616	22,993,028	9,892,796	2,959,671	86,609,111
Total	107,081,812,412	58,553,965,668	24,790,884,897	6,910,131,660	197,336,794,637