Laser Ranger Baseline System Validation - Five Point Zero Baseline Method
Slope Distance Reduction and Elevation Difference Calculation

Note: Fill in the yellow boxes with your baseline observations

Height of swivel point to laser ranger	0.27
Laser ranger constant value	0

SD equals slope distance
VA equals vertical angle in deci
TSD equals true slope distance
HD equals horizontal distance
El Diff equals elevation differen

Pt# equals point number
HT equals height of target

At point # 1
Height of swivel point 1.16

To Pt#	HT	SD	VA	TSD	HD	El Diff
2	0.25	6.001	-12	6.058	5.926	-0.074
3	0.25	11.731	-5.87	11.759	11.697	-0.021
4	0.25	23.224	-2.63	23.236	23.212	0.114
5	0.37	29.435	-2.15	29.445	29.424	-0.044

At point # 2
Height of swivel point 1.16

To Pt#	HT	SD	VA	TSD	HD	El Diff
1	0.25	6.019	-11.73	6.075	5.948	-0.049
3	0.25	5.854	-11.83	5.911	5.785	-0.026
4	0.25	17.323	-3.65	17.340	17.305	0.077
5	0.37	23.528	-2.75	23.541	23.514	-0.069

At point # 3
Height of swivel point 1.14

To Pt#	HT	SD	VA	TSD	HD	El Diff
1	0.25	11.739	-6	11.767	11.703	-0.069
2	0.25	5.869	-12	5.926	5.797	-0.066
4	0.31	11.583	-5.35	11.608	11.558	0.019
5	0.37	17.779	-3.67	17.796	17.760	-0.099

At point # 4
Height of swivel point 1.14

To Pt#	HT	SD	VA	TSD	HD	El Diff
1	0.25	23.244	-3.22	23.259	23.222	-0.146
2	0.25	17.35	-4.32	17.370	17.321	-0.148
3	0.31	11.589	-6.45	11.620	11.546	-0.204
5	0.31	6.306	-11.67	6.362	6.230	-0.181

At point # 5
Height of swivel point 1.14

To Pt#	HT	SD	VA	TSD	HD	El Diff
1	0.31	29.44	-2.22	29.450	29.428	-0.041
2	0.31	23.538	-2.82	23.551	23.523	-0.058
3	0.25	17.773	-3.82	17.791	17.752	-0.025
4	0.25	6.281	-10.02	6.329	6.232	0.063

Forward and Reverse Distance Comparisons

Line	Distance	Line	Distance	Difference	Mean	Line
1-2	5.926	2-1	5.948	0.022	5.937	a

1-3	11.697	3-1	11.703	0.006	11.700	b
1-4	23.212	4-1	23.222	0.011	23.217	c
1-5	29.424	5-1	29.428	0.004	29.426	d
2-3	5.785	3-2	5.797	0.012	5.791	e
2-4	17.305	4-2	17.321	0.016	17.313	f
2-5	23.514	5-2	23.523	0.009	23.518	g
3-4	11.558	4-3	11.546	0.012	11.552	h
3-5	17.760	5-3	17.752	0.008	17.756	i
4-5	6.230	5-4	6.232	0.002	6.231	j
			Average	**0.010**		

The following line sums provide an indication whether there is an unacceptable systematic error in the measuring system
The values in theory should be zero.

		Systematic	
Theoretical	**Actual**	**Error**	
a+e-b=0	0.028	0.028	
a+e+h-c=0	0.063	0.031	
a+f-c=0	0.033	0.033	**Note:** There appears to be a systematic error
b+h-c=0	0.035	0.035	of + 3 centimetres. I am not sure where
a+e+i-d=0	0.057	0.029	the error source is. Frankly, I am quite surprised
a+e+h+j-d=0	0.085	0.028	to discover this systematic error as the error source
b+h+j-d=0	0.057	0.028	is not obvious. I will have to investigate and test to
c+j-d=0	0.022	0.022	find the source. The constant error seems to be
a+f+j-d=0	0.055	0.027	very consistent. I should be able to reduce the error
a+g-d=0	0.029	0.029	budget to be similar to the one centimetre precision of
b+i-d=0	0.029	0.029	the measuring system that we saw above.
j+h-i=0	0.027	0.027	
j+h+e-g=0	0.056	0.028	
j+f-g=0	0.026	0.026	
e+h-f=0	0.030	0.030	
		0.029	**Mean**

Forward and Reverse Elevation Difference Comparisons

Line	Elev Diff	Line	Elev Diff	Difference	
1-2	-0.074	2-1	-0.049	-0.123	
1-3	-0.021	3-1	-0.069	-0.090	**Note:** These elevation differences are not
1-4	0.114	4-1	-0.146	-0.032	quite what I expected. I will have to perform
1-5	-0.044	5-1	-0.041	-0.085	additional baseline tests in order to determine
2-3	-0.026	3-2	-0.066	-0.092	how to reduce the error budget.
2-4	0.077	4-2	-0.148	-0.071	
2-5	-0.069	5-2	-0.058	-0.127	
3-4	0.019	4-3	-0.204	-0.185	
3-5	-0.099	5-3	-0.025	-0.123	
4-5	-0.181	5-4	0.063	0.244	
			Average	**-0.068**	

imals of degrees

ce