Final Project

BCEE 371 - Surveying

Concordia University

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Introduction

This project explores the combined use of a Total Station and a tape measure for comprehensive building and surroundings survey for a structure located on the Loyola campus of Concordia University. The Total Station's precision in measuring angles and distances, combined with the tape measure's reliability, creates a powerful yet cost-effective approach. We delve into the operating mechanisms and individual strengths of both tools, showcasing their convenient use in different surveying applications. By providing practical field knowledge, this study equips future civil engineers with valuable skills to accurately assess and interpret survey data, ensuring success in construction projects and land analysis.

Objective

The main goal of this project is to use different surveying techniques from class to determine the dimensions of Building HU and all surrounding landmarks.

Equipment and material

- Total station
- Measuring Tape
- Plum bob
- Field book
- TPC software
- Autocad software
- Pins
- Hammer

Procedure

1. Set up 5 different points around building HU making sure the building and all surrounding landmarks are visible.
2. Measure the following points using the total station:
    - Interior angles in the shape created by these 5 points.
    - Measure the distance from each point to the building and landmarks.
    - Measure the dimensions of the building.
3. Measure the dimensions of all the landmarks and important features using the measuring tape.
4. Record all the data collected in the field book.
5. Once all the important data points are collected. Use TPC software to determine the boundaries and correct the errors.
6. Transport the data from TPC to Autocad.
7. Create the Final sketch from the data exported from TPC, and add all the important features and landmarks.

Building Photos

Point A view:

Point B view:

Point C view:

View from side DE:

View from side AE:

Data collected

Table 1: Interior Angles of the Traverse

PT	Deg	Min	Sec
A	115	39	30
B	107	06	00
C	128	10	30
D	113	38	20
E	75	29	00

Table 2: Horizontal Distance of the Traverse

Course	Distance (m)
A-B	45.018
B-C	33.858
C-D	48.127
D-E	57.840

E-A	67.475

Table 3: Horizontal Angles and Distances of Landmarks Taken from Point A

	Deg	Min	Sec	Course	Distance(m)
E-T1	108	25	10	A-T1	10.421
E-T2	73	15	50	A-T2	9.423
E-T3	43	06	50	A-T3	12.000
E-T4	26	42	00	A-T4	16.338
E-T5	10	40	00	A-T5	31.397
E-T6	8	28	10	A-T6	36.058
E-T7	6	51	00	A-T7	40.683
E-T8	5	09	20	A-T8	45.314
E-Statue	13	32	50	A-S	26.404
E-L1	37	55	10	A-L1	13.669
E-L2	20	23	10	A-L2	20.154
E-L3	15	15	30	A-L3	24.502
E-L4	11	32	50	A-L4	29.055
E-L5	8	52	00	A-L5	33.591
E-L6	6	51	00	A-L6	38.207
E-L7	5	20	50	A-L7	42.867

Legend:

- T: Tree
- L: Lamps

Table 4: Vertical Angles and Distances of Landmarks Taken from Point A

PT	Deg	Min	Sec
T1,2,3,4 - Top	+18	48	30
Bottom	-8	25	40
T5 - Top	+2	10	40
Bottom	-3	09	10
T6,7,8 – Top	+4	13	50
Bottom	-2	41	30
L1 (large) - Top	+14	08	30
Bottom	-8	25	40
L2-7 - Top	-2	12	50
Bottom	-4	38	40
Statue - Top	+13	58	20
Bottom	-3	35	30

Legend:

- T: Tree
- L: Lamps

Table 5: Horizontal Angles and Distances from A to Building

PT	Deg	Min	Sec
E-B2/Top	12	25	10
Bottom	12	26	10
E-B1/Top	67	56	20
Bottom	64	27	00

A-B1	16.124 m		

Table 6: Vertical Angles and Distances from A to Building

PT	Deg	Min	Sec
A-B1/Top	+58	48	20
	+10	00	30
A-B1/Bottom	+9	10	00
	-5	49	50
A-B2	+29	43	10
	-2	19	10

Table 7: Horizontal Angles from B to Building

PT	Deg	Min	Sec	Course	Distance (m)
A-B1/Top	17	15	20	B-B1/Bottom	37.236
A-B1/Bottom	19	58	40	B-B2/Top	36.997
A-B4/Top	79	52	00	B-B4/Top	30.875
A-B4/Bottom	77	55	10	B-B4/Bottom	31.973

Table 8: Vertical Angles from Point B

PT	Deg	Min	Sec	Distance (m)
B-Top	39	22	40	
B-Lip	3	58	00	28.850
B-Bottom	-4	14	00	30.188
B-Trees	+3	55	10	17.412

	-7	04	40	

Table 9: Horizontal Angles and Distances for Building from Point C

PT	Deg	Min	Sec	Distance (m)
C-B1/Top	111	26	30	
C-B4/Top	65	38	50	45.576
C-B1/Bottom	111	19	10	45.561
C-B4/Bottom	69	32	30	16.538

Table 10: Horizontal and Vertical Angles for Bridge from E

PT	Deg	Min	Sec	Distance (m)
Bottom Bridge (V)	+14	47	30	
Top Bridge (V)	+24	52	40	
Bottom B2 (V)	-3	04	40	
D-Bottom Bridge (H)	57	31	40	27.319

Table 11: Horizontal and Vertical Angles from D

PT	Deg	Min	Sec	Distance (m)
C-B3 (H)	70	48	00	13.990
C-B2 (H)	82	34	00	48.740
C-Trees (H)	15	25	00	30.179

D-B3/Top (V)	9	08	00	
D-B3/Bottom (V)	-2	57	10	

Table 12: Horizontal distances

PT	Distance (m)
B1B2- Curve (EA)	8.070
B1 railing	6.038
B4 railing	5.860
B1B4-10	8.530
9-10	4.100
10-13	4.170
8-9	8.000
12-13	7.630
27-28	4.160
27-29	3.520
B1B4-Grass	18.460
B3B4-Grass	2.840
B3B2-Grass	7.620
curve	0.200

Results

Traverse PC data

Traverse View - 1 (Grid Bearing, Grid Dist, Meters)
4152.30SqM 0.415Hectares Grid Dist (grid or local Cartesian coordinates)
Grid Bearing (grid or local Cartesian coordinates)
File: Untitled Date:8-5-2023

Point	Type	Grid Bearing	Grid Dist	Northing	Easting	Description
1				-0.009	0.017	
2		S26°11'08"W	44.98	-40.376	-19.834	
3		N89°25'46"W	67.47	-39.705	-87.305	
4		N15°04'14"E	57.84	16.146	-72.266	
5		N81°28'14"E	48.23	23.299	-24.571	
1		S46°31'46"E	33.88	-0.009	0.017	

C:\Users\Owner\Dropbox\My PC (LAPTOP-4PDPILU5)\Documents\Surveys\Untitled.TRV
[[Closure View - 1]]
Saturday, August 05, 2023 23:41:16
Meters Factor=1.00000000
Grid Dist (grid or local Cartesian coordinates)
Grid Bearing (grid or local Cartesian coordinates)

[Traverse Summary]
Closed Loop 6 Points From 1 To 1
Horizontal Distance: 252.41 Meters Slope Distance: 252.41 Meters
Area: 4152.301 SqM 0.415 Hectares

[Error Summary]
Relative: 1:0 (Closed Loop) Linear:0.00 Meters Direction:N0°00'00"E
Northing:0.00 Meters Easting:0.00 Meters Elevation:0.00 Meters
Angular: None

[Warnings]

[Rectangular Limits (PLSS)]
Latitude 1:0 Departure 1:0

[Closing Points]

	Point	Northing	Easting	Elevation
From	1	-0.009	0.017	0.00
To	1	-0.009	0.017	0.00

[Adjustments]
Coordinates-Compass

[Adjustment Details]

Point:1 Desc:
  Adjusted : N:-0.009 E:0.017 Z:0.00
  Raw : N:-0.013 E:0.021 Z:0.00
  Difference: N:0.003 E:-0.004 Z:0.00
  Linear Error: 0.00 Meters Relative Error: 0

Point:2 Desc:
  Adjusted : N:-40.376 E:-19.834 Z:0.00
  Raw : N:-40.380 E:-19.830 Z:0.00
  Difference: N:0.003 E:-0.004 Z:0.00
  Linear Error: 0.00 Meters Relative Error: 9294

Point:3 Desc:
  Adjusted : N:-39.705 E:-87.305 Z:0.00
  Raw : N:-39.708 E:-87.302 Z:0.00
  Difference: N:0.003 E:-0.004 Z:0.00
  Linear Error: 0.00 Meters Relative Error: 23234

Point:4 Desc:
  Adjusted : N:16.146 E:-72.266 Z:0.00
  Raw : N:16.143 E:-72.263 Z:0.00
  Difference: N:0.003 E:-0.004 Z:0.00
  Linear Error: 0.00 Meters Relative Error: 35184

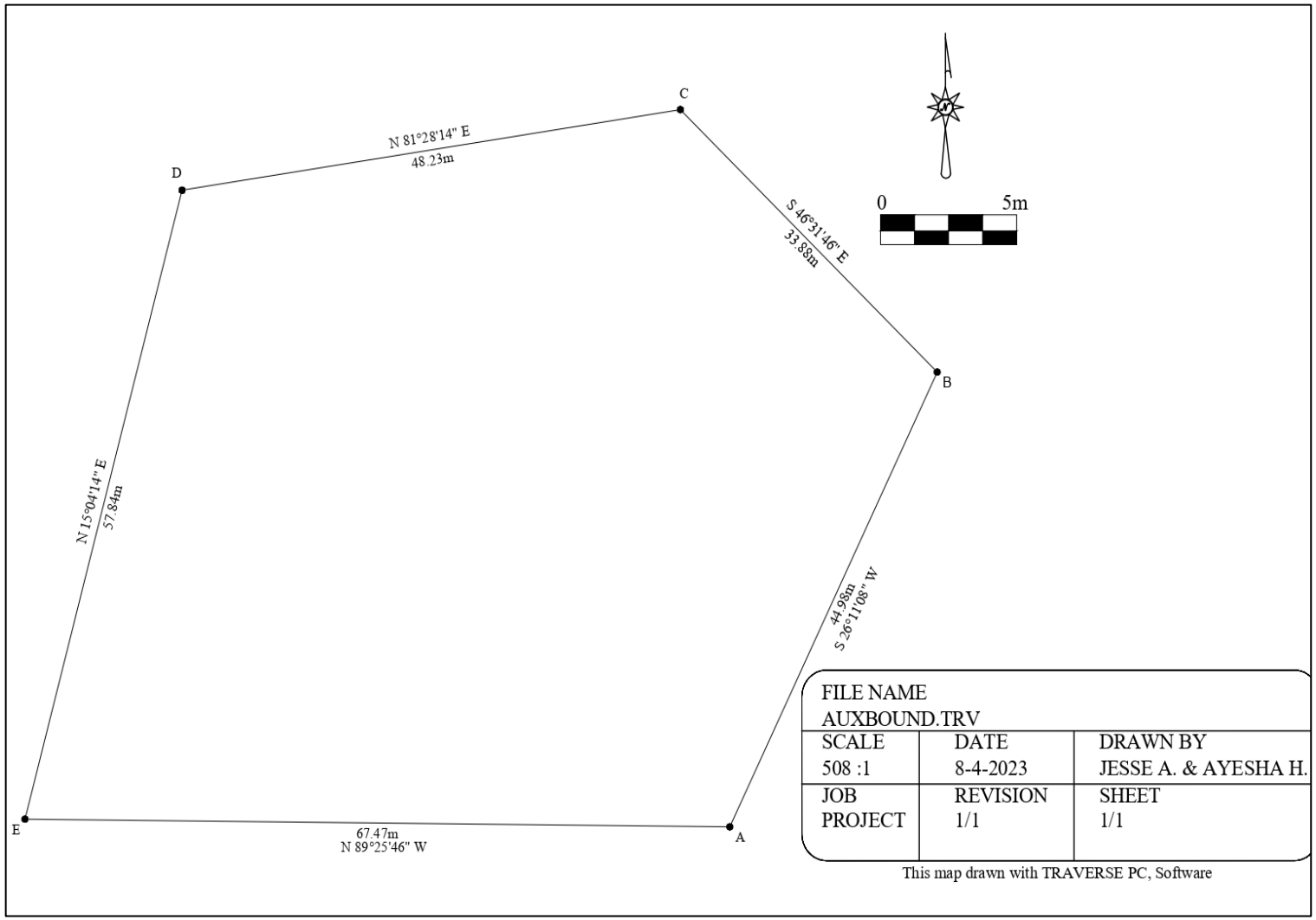
Point:5 Desc:
  Adjusted : N:23.299 E:-24.571 Z:0.00

C:\Users\Owner\Dropbox\My PC (LAPTOP-4PDPILU5)\Documents\Surveys\Untitled.TRV
  Raw : N:23.296 E:-24.567 Z:0.00
  Difference: N:0.003 E:-0.004 Z:0.00
  Linear Error: 0.00 Meters Relative Error: 45148

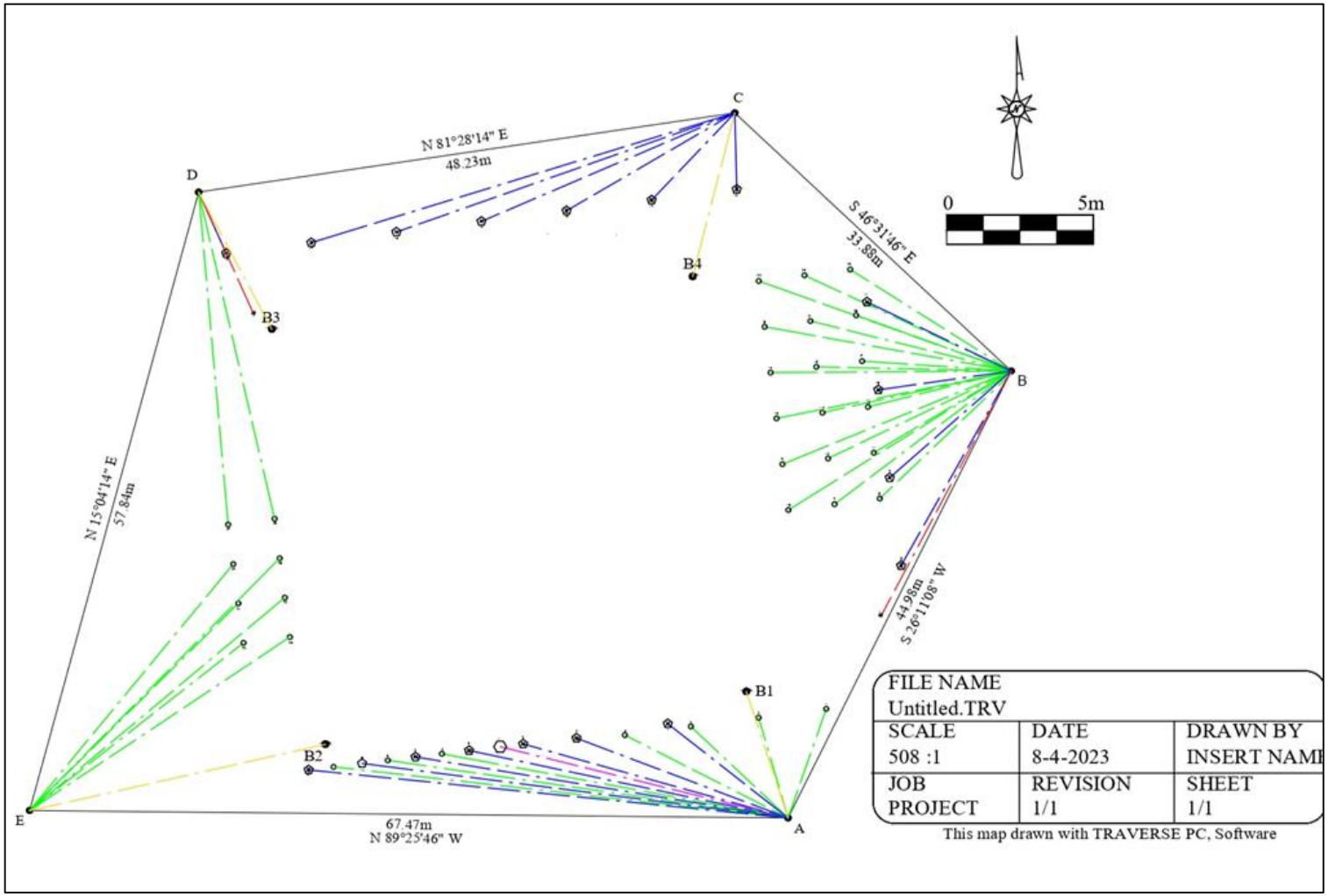
Point:1 Desc:
  Adjusted : N:-0.009 E:0.017 Z:0.00
  Raw : N:-0.013 E:0.021 Z:0.00
  Difference: N:0.003 E:-0.004 Z:0.00
  Linear Error: 0.00 Meters Relative Error: 52147

HU building layouts

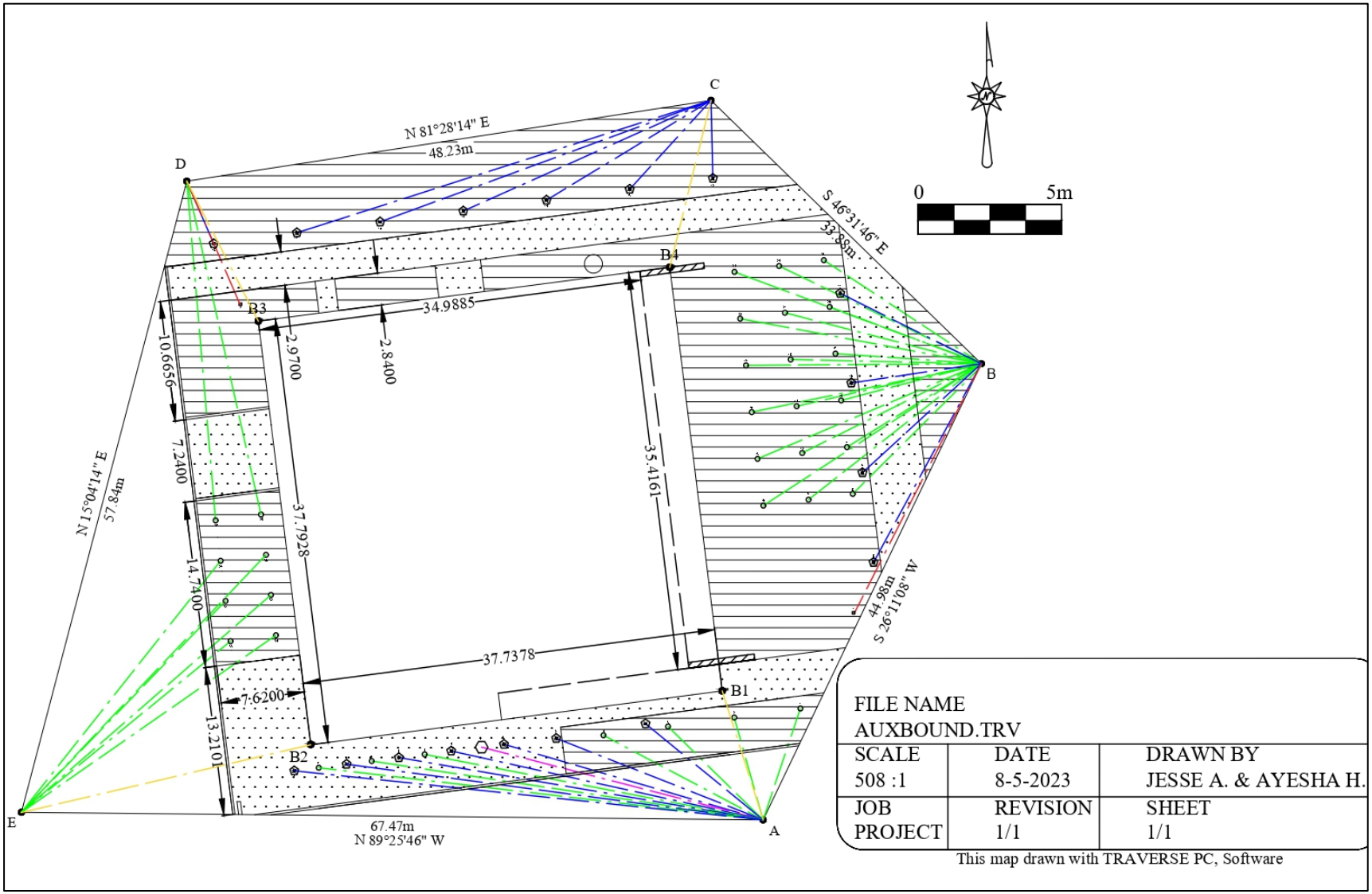
Drawing 1: layout of traverse

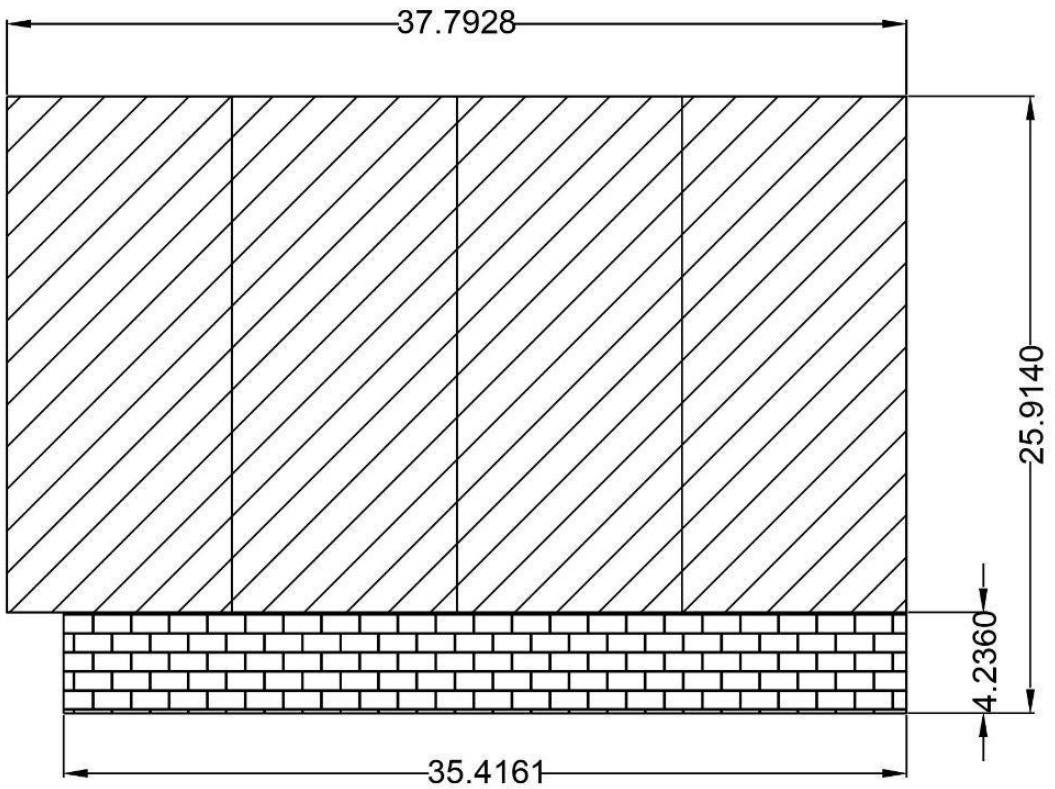


Drawing 2: layout of side shots

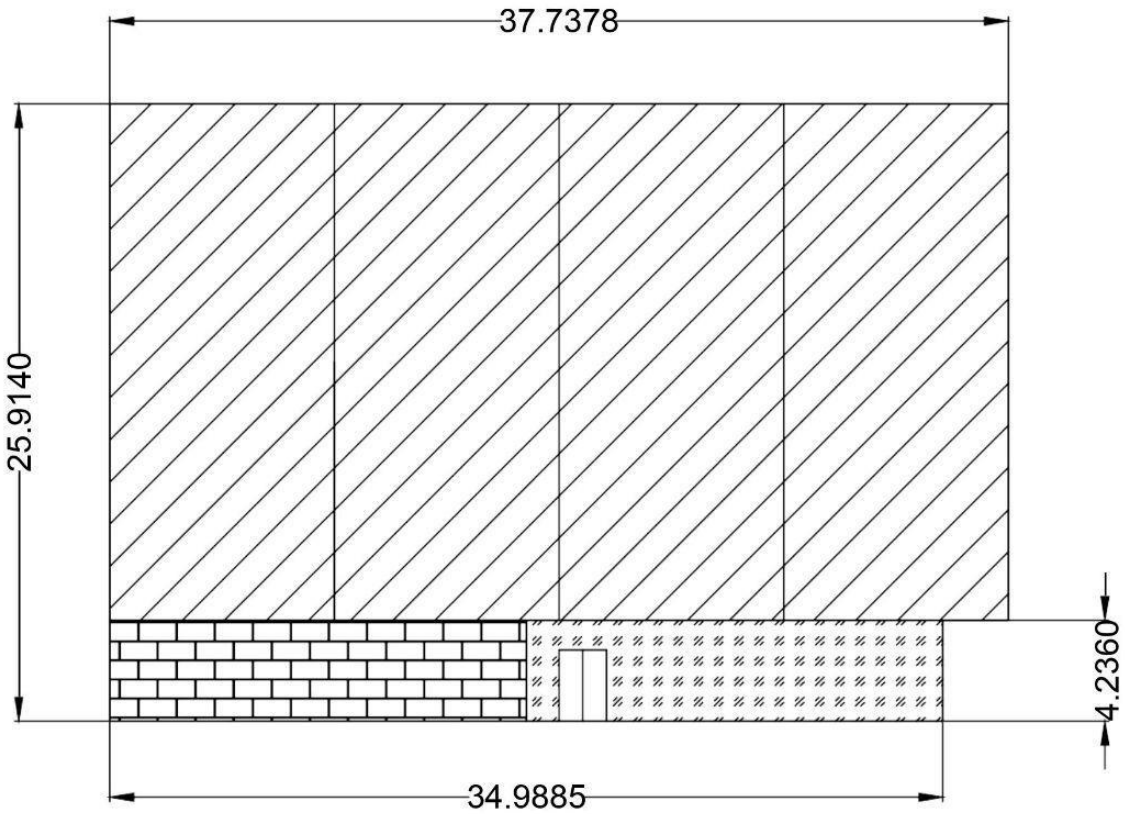


Drawing 3: General layout





CONCORDIA UNIVERSITY Faculty of Engineering & Computer Science		BCEE 371 Surveying	PLAN NO. 2
DRAWN BY:	Group 8	SCALE: 300:1	Side view of the building
DATE:	August 4, 2023		



CONCORDIA UNIVERSITY Faculty of Engineering & Computer Science		BCEE 371 Surveying	PLAN NO. 1
DRAWN BY:	Group 8	SCALE: 300:1	Front view of the building
DATE:	August 4, 2023		

Calculations

Angles correction

Table 13: Corrected interior Angles of the Traverse

Point	Experimental angle	Corrected angle
A	115°39’30”	115°38’50”
B	107°06’00”	107°05”20
C	128°10”30	128°09’50”
D	113°38”20	113°37’40”
E	75°29’00”	75°28”20”
sum	540°03’20”	540°00’00”
Error	-0°03’20”	

Required sum of corrected angle

$$\Sigma interior\ angles = 180 \times (n-2) = 180 \times (5-2) = 540°00'00"$$

Angle correction

$$Angle\ correction = \frac{error}{5} = \frac{-0°03'20"}{5} = -00°00'40"$$

Acceptable error

$$C = \pm K\sqrt{n}$$

$$C = \pm 20"\sqrt{5} = -00°00'44.72"$$

The error per angle is smaller than the acceptable error.

Error of closure and precision

$$\boldsymbol{Error\ of\ closure} = \sqrt{(\boldsymbol{\Sigma Latitude})^2 + (\boldsymbol{\Sigma departure})^2}$$

$$Precision = \frac{Error\ of\ closure}{parameter}$$

- Error of closure = 0.019235384
- Precision = 7.620992101*10^ (-5)

Discussion

Upon gathering all the required field measurements, data analysis was performed utilizing the TPC and Autocad software. This analytical approach facilitated the creation of precise sketches for the traverse, building (HU), and surrounding features. Following verification, minor corrections were implemented for interior angles, with deviations of only -40 seconds per angle, well below the acceptable error threshold of 44.72 seconds. The error of closure demonstrated exceptional performance, measuring around 0.019, underscoring the remarkably high precision achieved in the measurements. Such exemplary accuracy contributed significantly to the overall success of the project. Nonetheless, despite the exceptional precision and accuracy, slight deviations in the measurements were observed, which could be attributed to factors such as inadequate total station leveling, misalignment of the cross with the next point, or other minor human errors that may have occurred during the experimentation phase.

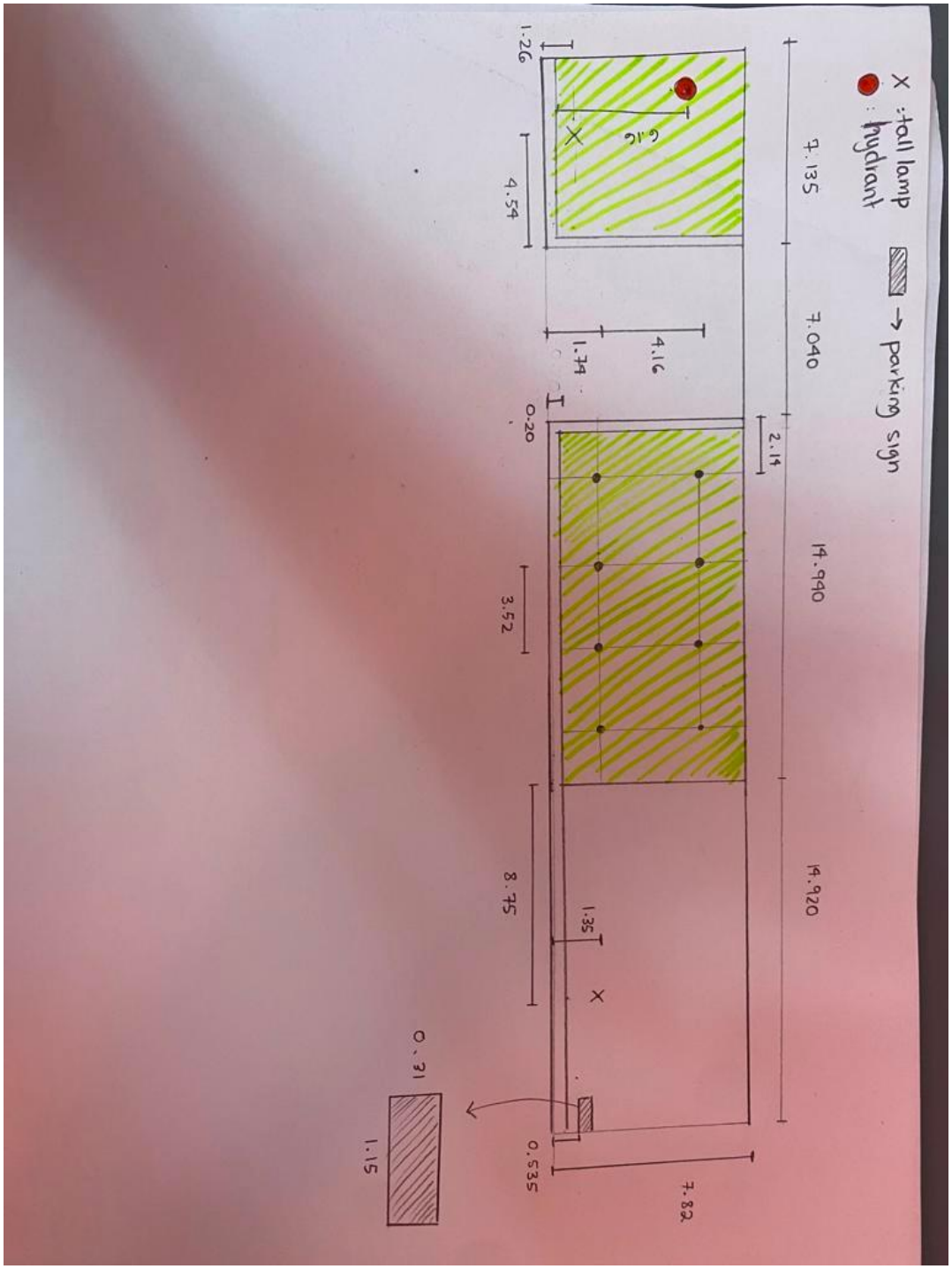
Conclusion

In conclusion, the combined use of a Total Station and a tape measure proved highly effective for the comprehensive building and surroundings survey at Concordia University's Loyola campus. The precision of the Total Station and the reliability of the tape measure contributed to accurate data collection and analysis. Results showcased exceptional accuracy in interior angles and a low error of closure. While minor deviations were observed, emphasizing meticulous surveying techniques and instrument calibration can further enhance measurement accuracy. Aspiring civil engineers can now approach construction projects and land analysis with increased confidence, armed with invaluable skills gained from this successful surveying endeavor.

Table of contributions

Ayesha Hossain	Autocad (side shots layout, general layout) , Calculations, Formatting, Appendices
Jesse Anderson	TPC calculations, Autocad (traverse layout, side shots layout, general layout), Appendices
Rayan Hatem	Introduction, Procedure, Calculations, Discussion, conclusion
Spencer	Collected data
Eric	Autocad (side views)

Appendices



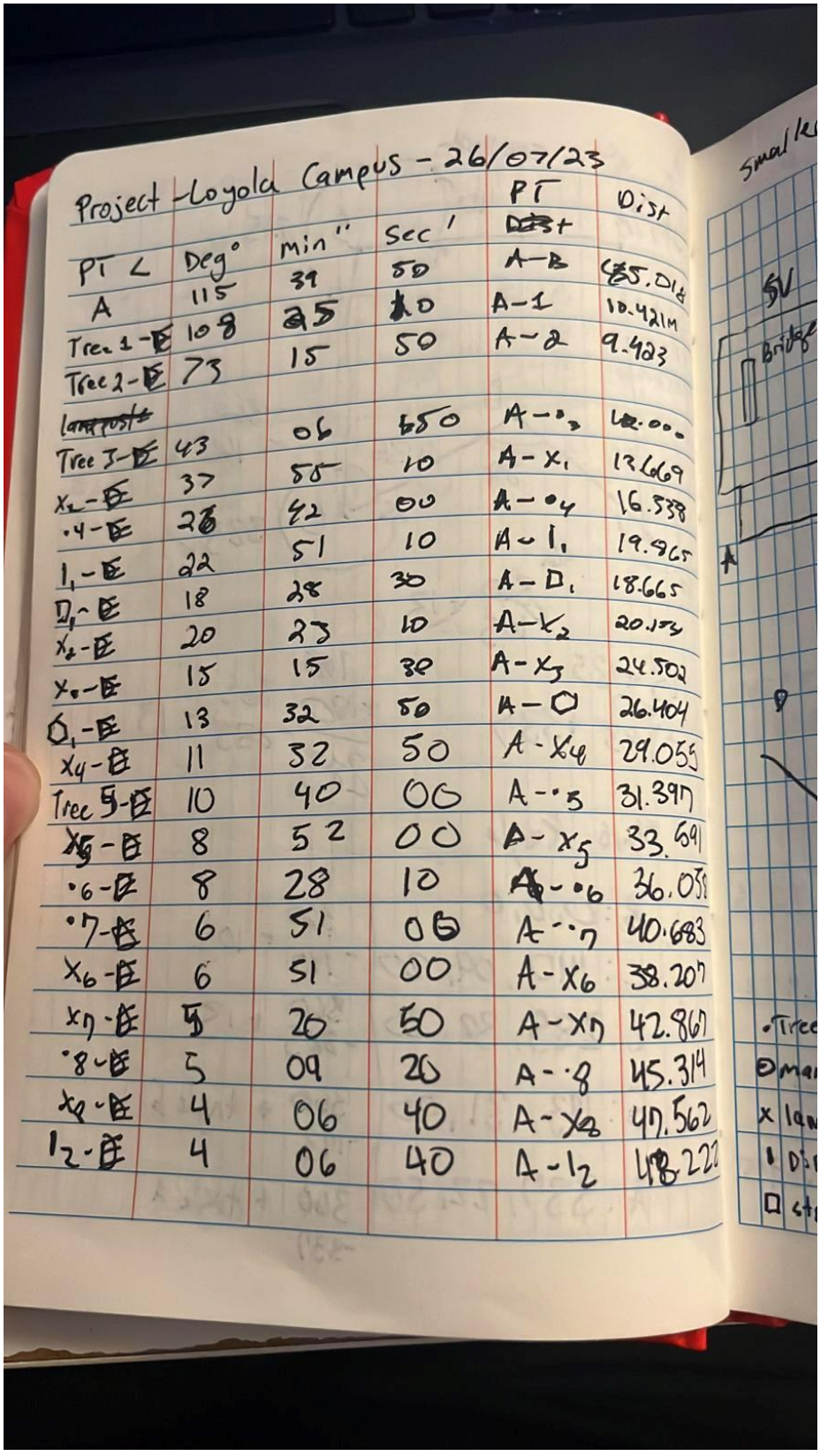
Appendix 1

manhole
Lamp
hydrant
x tall lamp
32.45
5.86
4.10
1.17
2.89
2.97
6.94
7.63
4.13
9.20
1.80
13.38
2.54
6.16
1.28
0.20

Appendix 2

= hydrant, dia = 0.24, height = 0.63
X = Lamp, dia = 0.2005
= tree
6.038
13.42
8.53
4.10
4.10
6.58
2.97
1.73
0.62
0.62
7.17
8.00
8.00
8.00
5.80
4.17
4.17
3.55
18.46
5.05

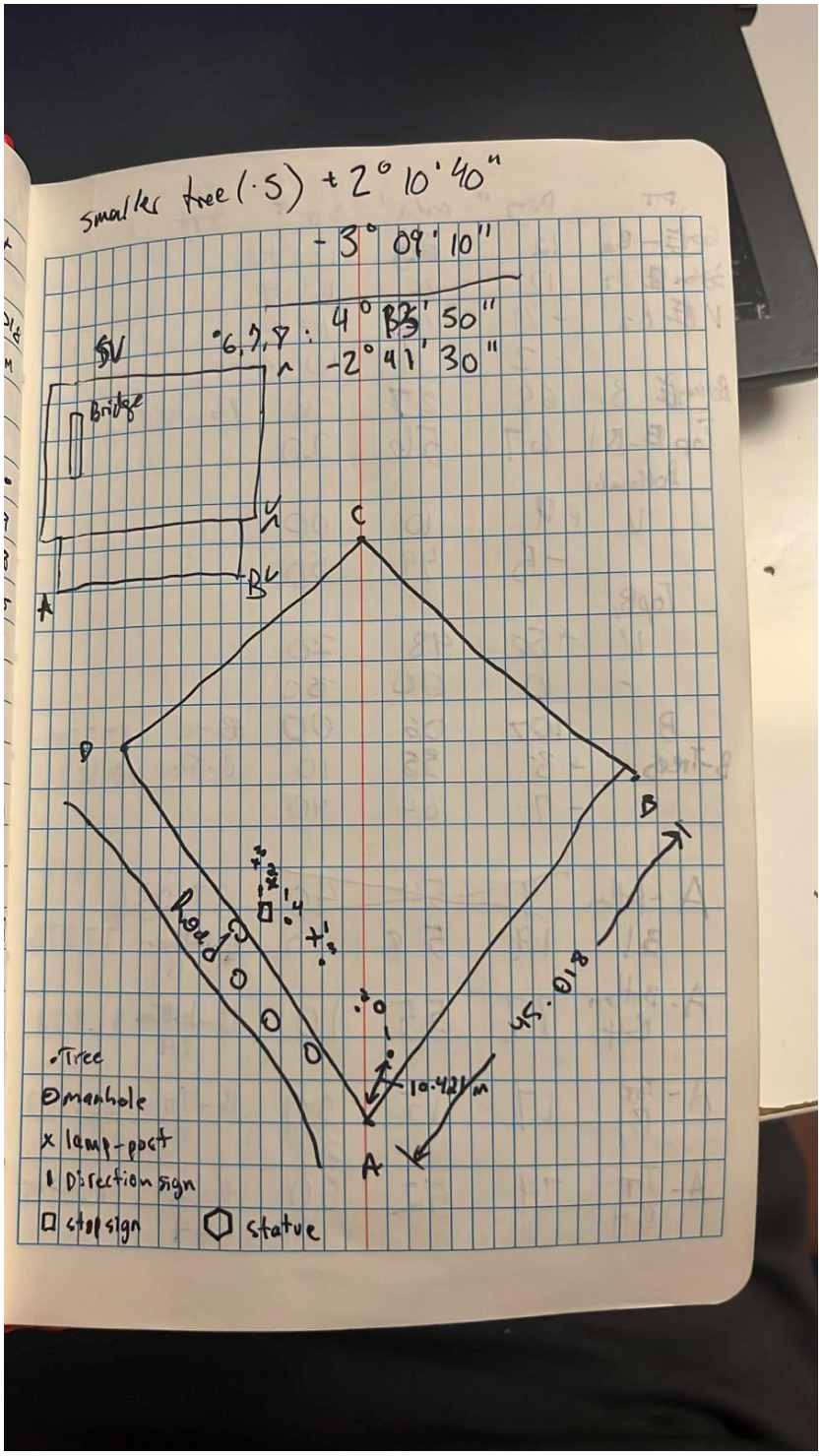
Appendix 3



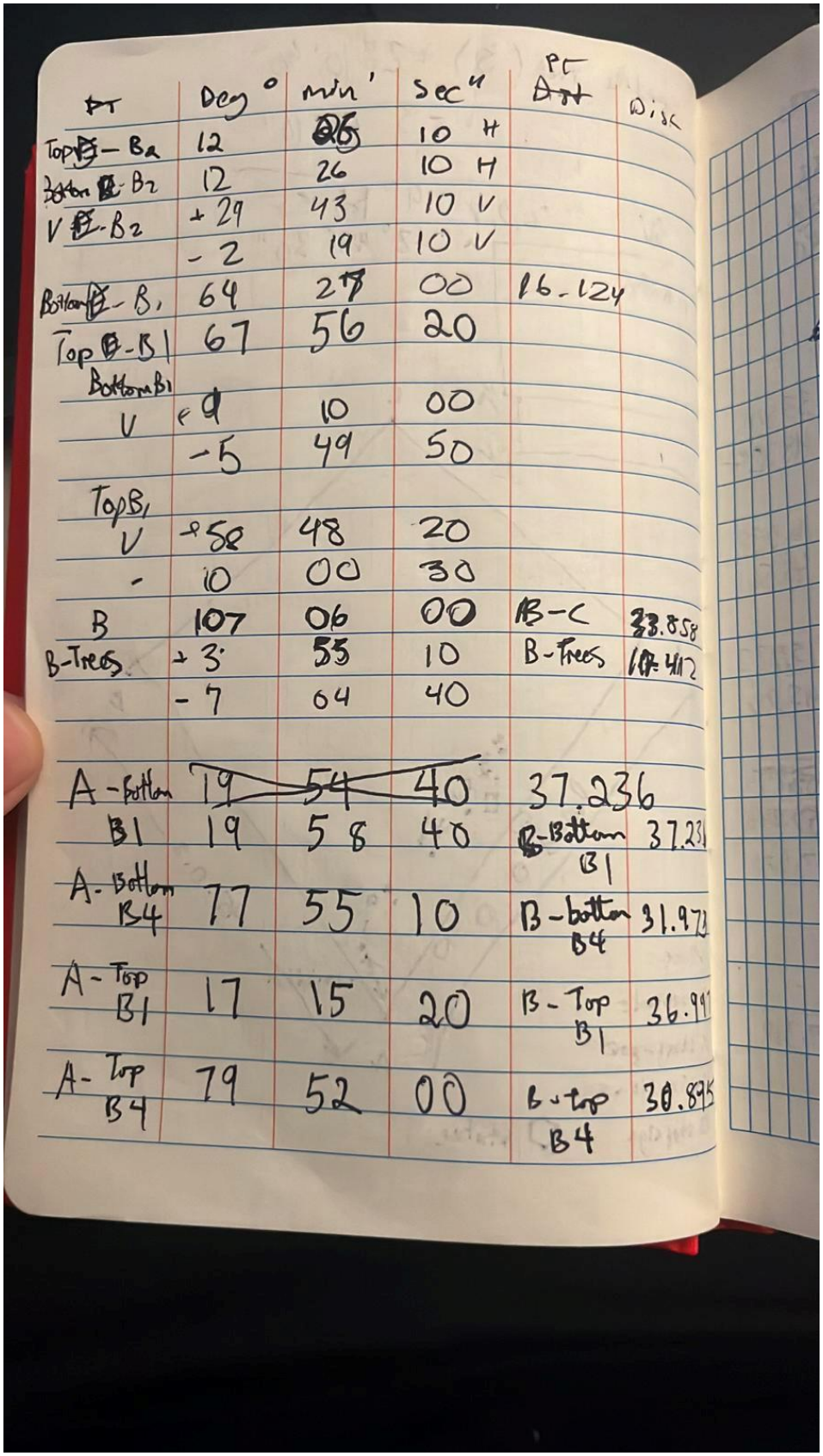
Project Loyola Campus - 26/07/23

PT ∠	Deg°	min'	Sec''	PT Dist	Dist
A	115	39	50	A–B	485.014
Tree 1–E	108	25	10	A–1	10.421M
Tree 2–E	73	15	50	A–2	9.423
~~lamppost~~					
Tree 3–E	43	06	550	A–•3	42.000
X2–E	37	55	10	A–X1	12.669
•4–E	28	42	00	A–•4	16.538
1,–E	22	51	10	A–1,	19.965
D,–E	18	28	30	A–D,	18.665
X2–E	20	23	10	A–X2	20.173
X3–E	15	15	30	A–X3	24.502
O,–E	13	32	50	A–O	26.404
X4–E	11	32	50	A–X4	29.055
Tree 5–E	10	40	00	A–•5	31.397
X5–E	8	52	00	A–X5	33.691
•6–E	8	28	10	A–•6	36.058
•7–E	6	51	05	A–•7	40.683
X6–E	6	51	00	A–X6	38.207
X7–E	5	26	50	A–X7	42.867
•8–E	5	09	20	A–•8	45.314
X8–E	4	06	40	A–X8	47.562
12–E	4	06	40	A–12	48.222

Appendix 4

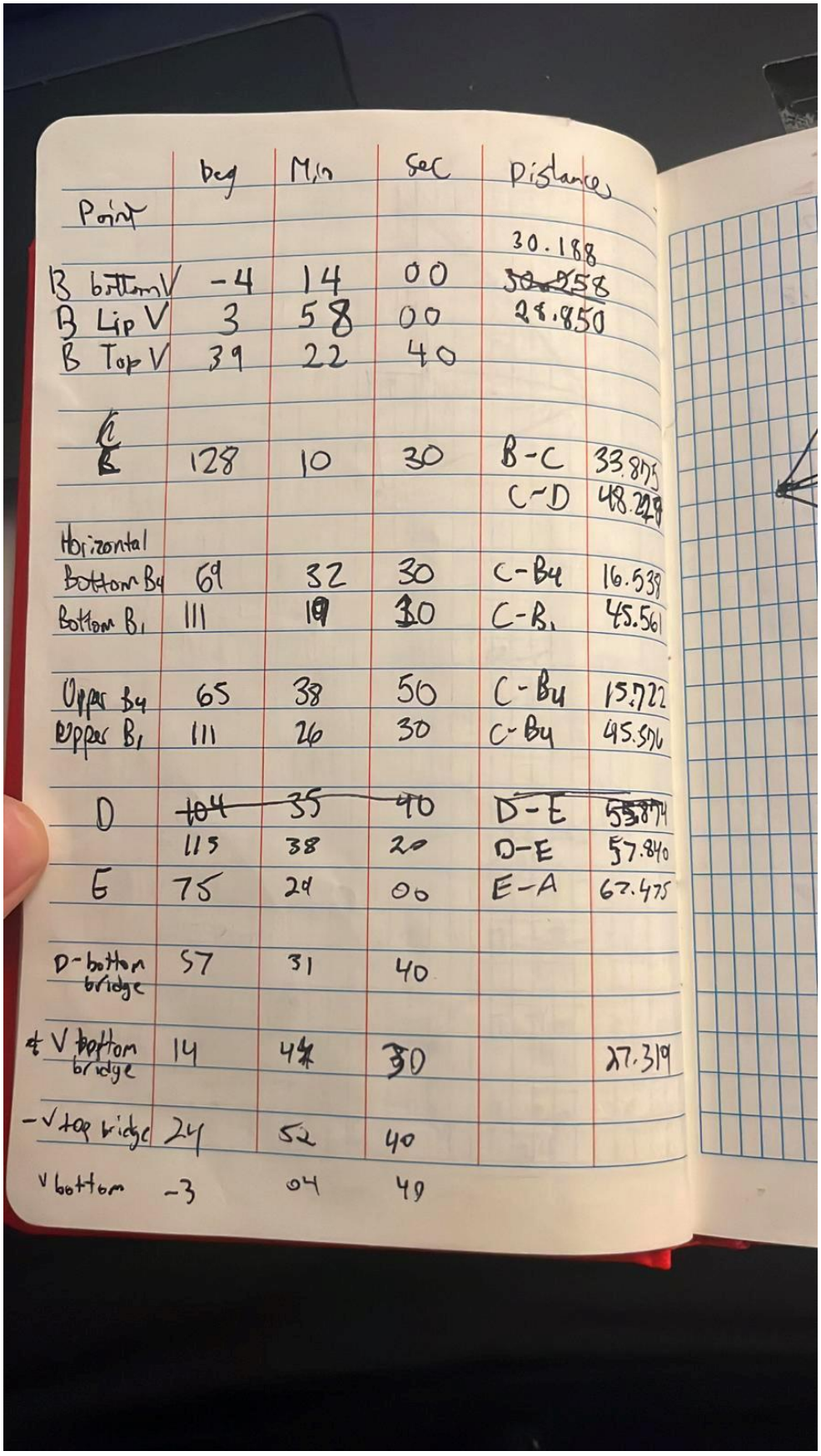

smaller tree (·S) + 2° 10' 40"
- 3° 09' 10"
6,7,8 : 4° 53' 50"
-2° 41' 30"
SW
Bridge
N
C
A
B
D
B
Road
45.018
10.421 m
A
·Tree
Manhole
x lamp-post
Direction sign
stop sign
statue

Appendix 5



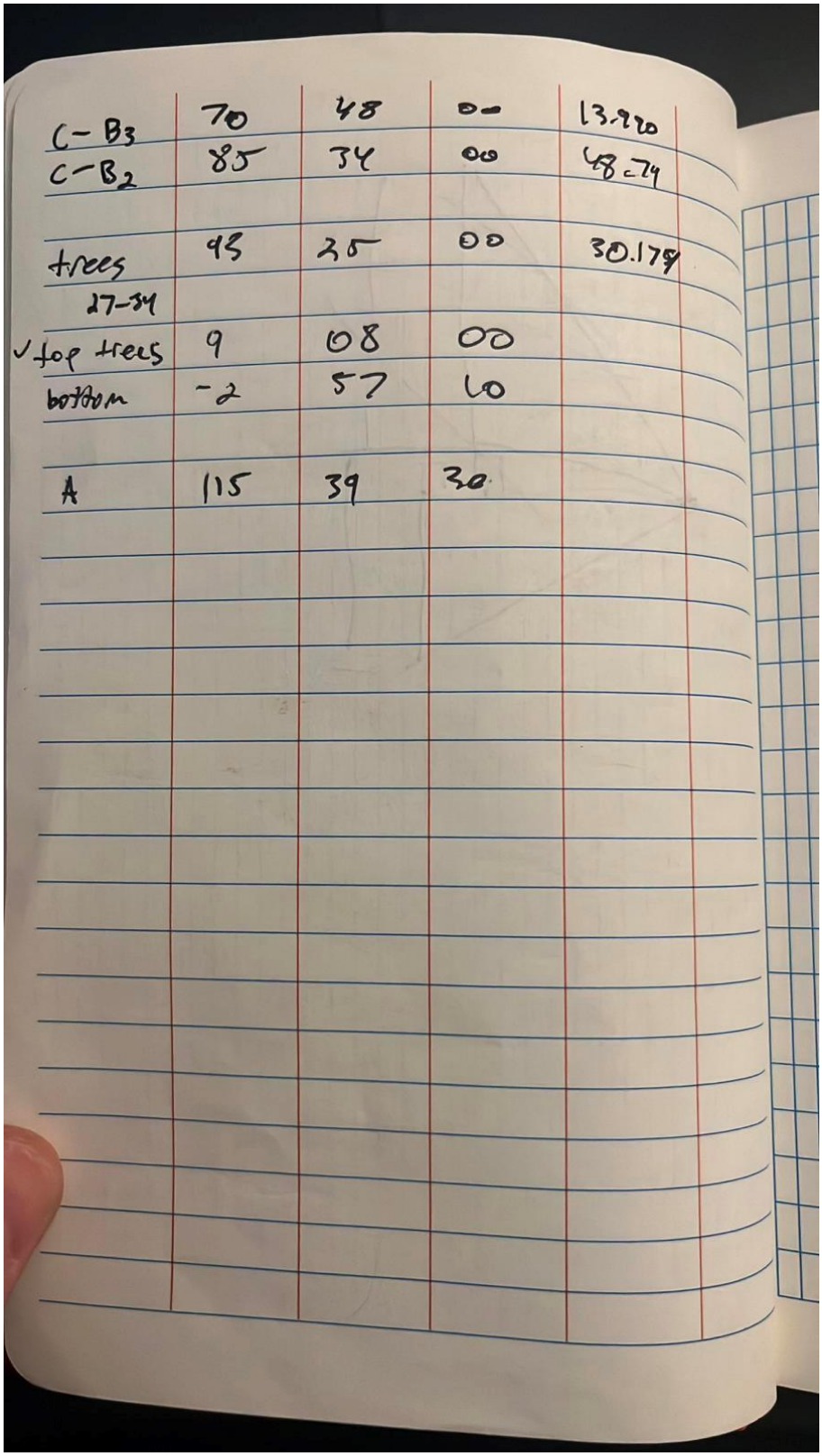
PT	Deg °	min '	sec "	PT Dist	Disc
Top B – B_2	12	25	10 H		
Bottom B – B_2	12	26	10 H		
V B – B_2	+ 29	43	10 V		
	- 2	19	10 V		
Bottom B – B_1	64	27	00	16.124	
Top B – B_1	67	56	20		
Bottom B_1 V	+ 9	10	00		
	-5	49	50		
Top B_1 V	+ 58	48	20		
-	10	00	30		
B	107	06	00	B – C	33.858
B-Trees	+ 3°	55	10	B – Trees	17.412
	- 7	04	40		
A – Bottom B1	~~19~~	~~54~~	~~40~~	37.236	
	19	58	40	B – Bottom B1	37.231
A – Bottom B4	77	55	10	B – bottom B4	31.972
A – Top B1	17	15	20	B – Top B1	36.997
A – Top B4	79	52	00	B – top B4	30.895

Appendix 6

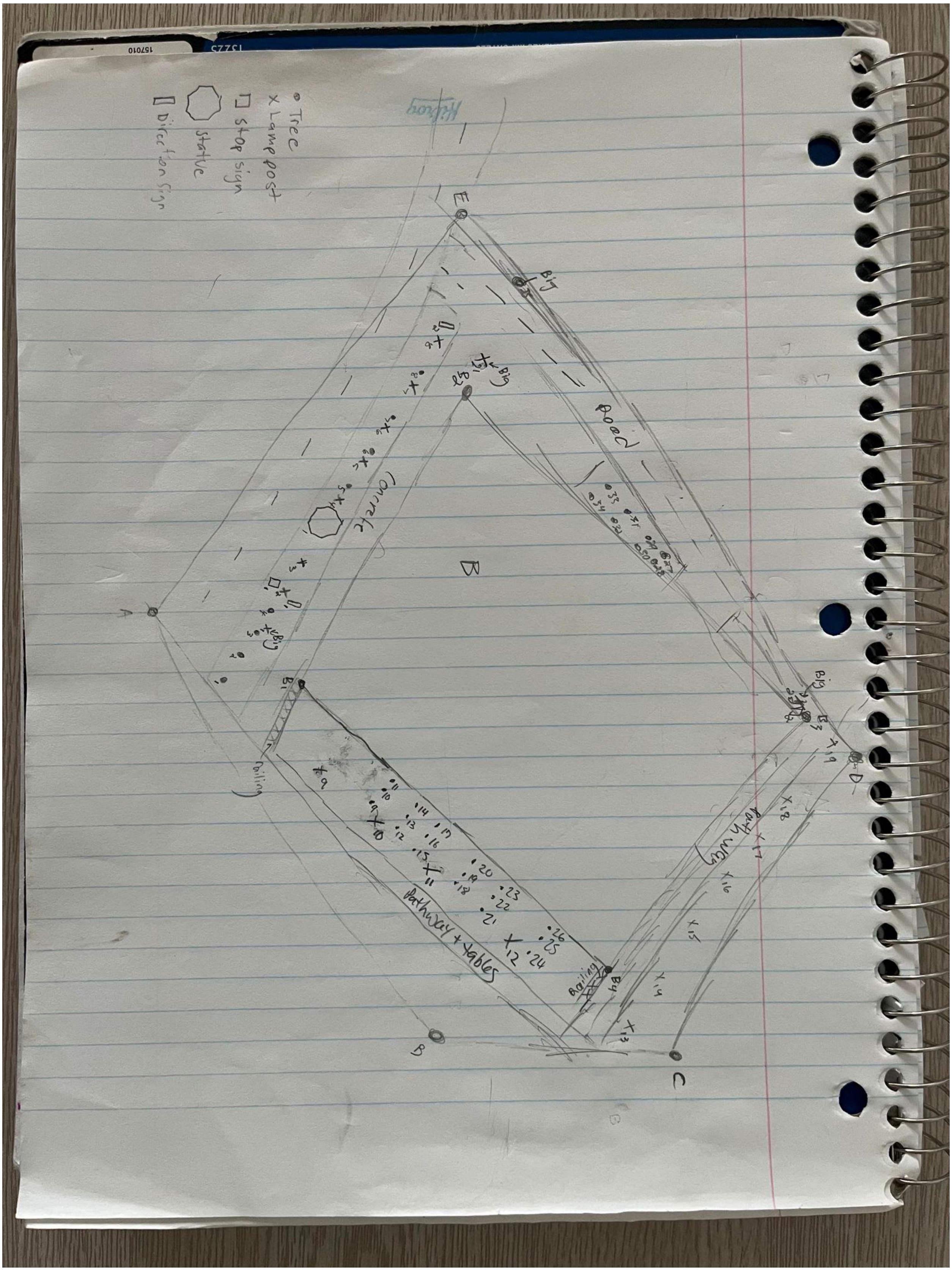


Point	Deg	Min	Sec	Distance	
					30.188
B bottom V	-4	14	00		~~30.858~~
B Lip V	3	58	00		28.850
B Top V	39	22	40		
~~C~~ B	128	10	30	B-C	33.875
				C-D	48.224
Horizontal					
Bottom B4	69	32	30	C-B4	16.539
Bottom B1	111	19	30	C-B1	45.561
Upper B4	65	38	50	C-B4	15.722
Upper B1	111	26	30	C-B4	45.576
D	~~104~~	~~35~~	~~40~~	D-E	~~55.874~~
	115	38	20	D-E	57.840
E	75	24	00	E-A	67.475
D-bottom bridge	57	31	40		
~~4~~ V bottom bridge	14	44	30		17.319
-V top bridge	24	52	40		
V bottom	-3	04	49		

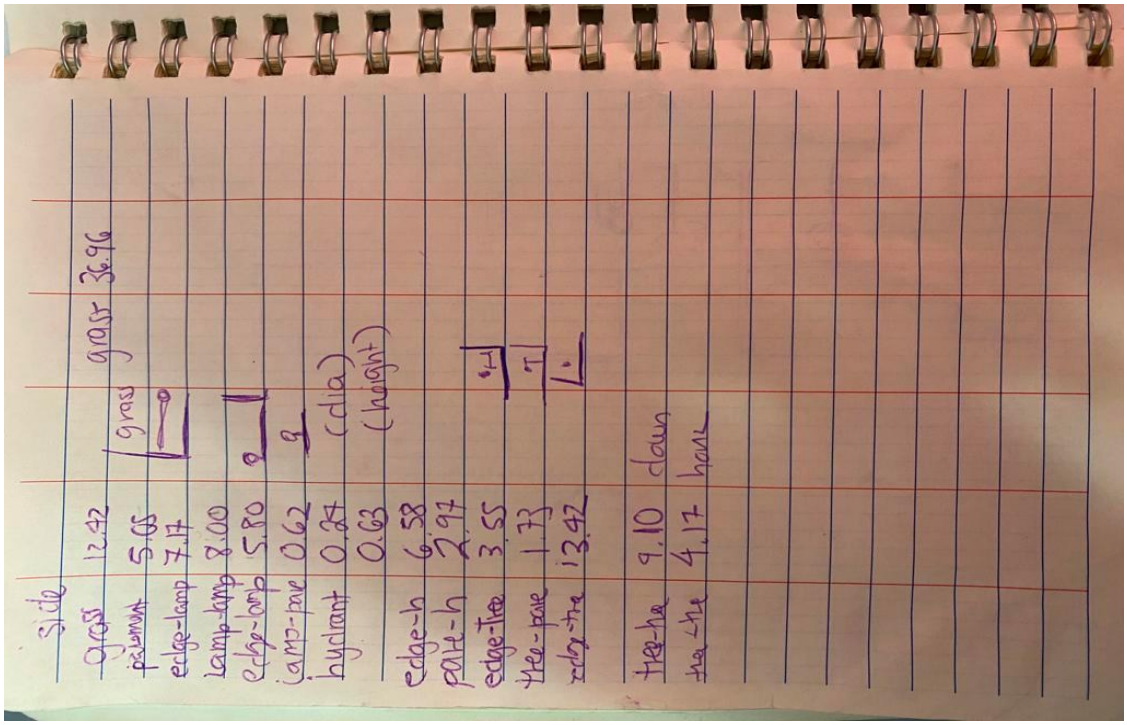
Appendix 7


C-B3 70 48 00 13.920
C-B2 85 34 00 48.74
trees 95 25 00 30.179
27-34
top trees 9 08 00
bottom -2 57 60
A 115 39 30

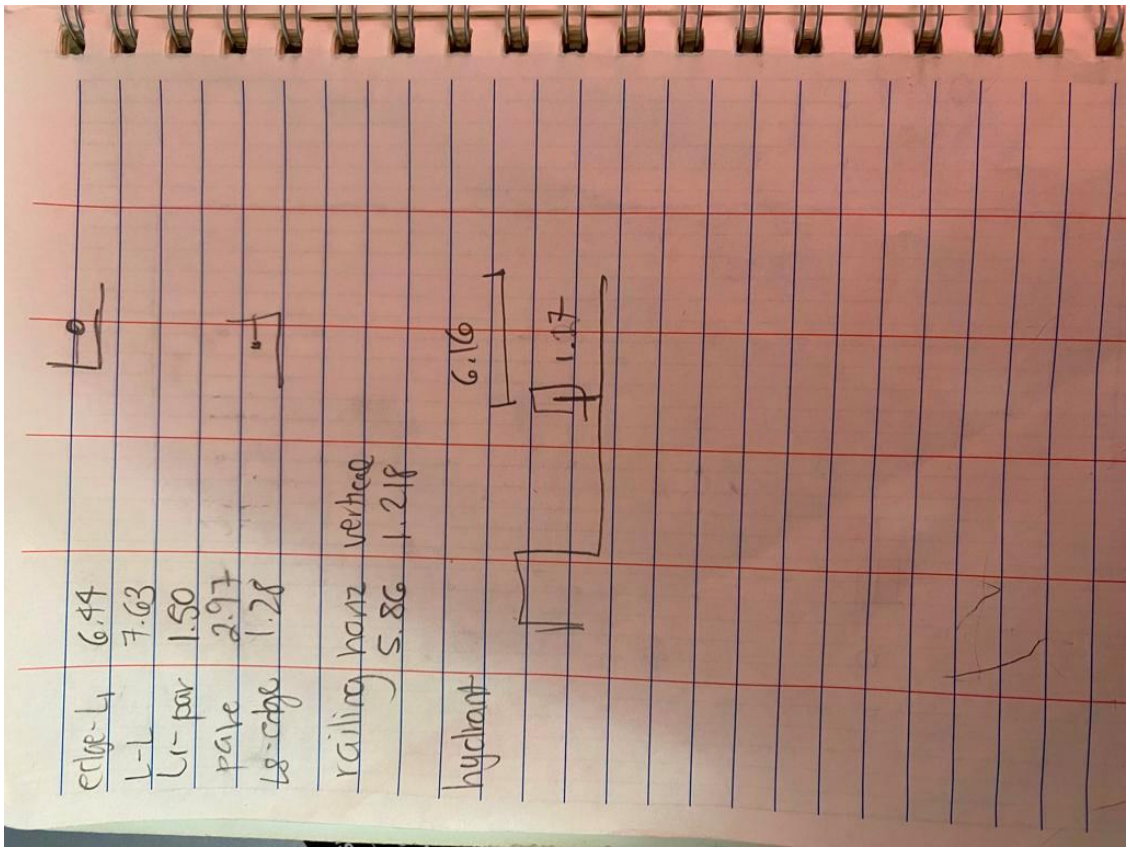
Appendix 8


Tree
X Lamp post
Stop sign
Statue
Direction Sign
Road
Concrete
Pathway + tables
Railing
Pathway

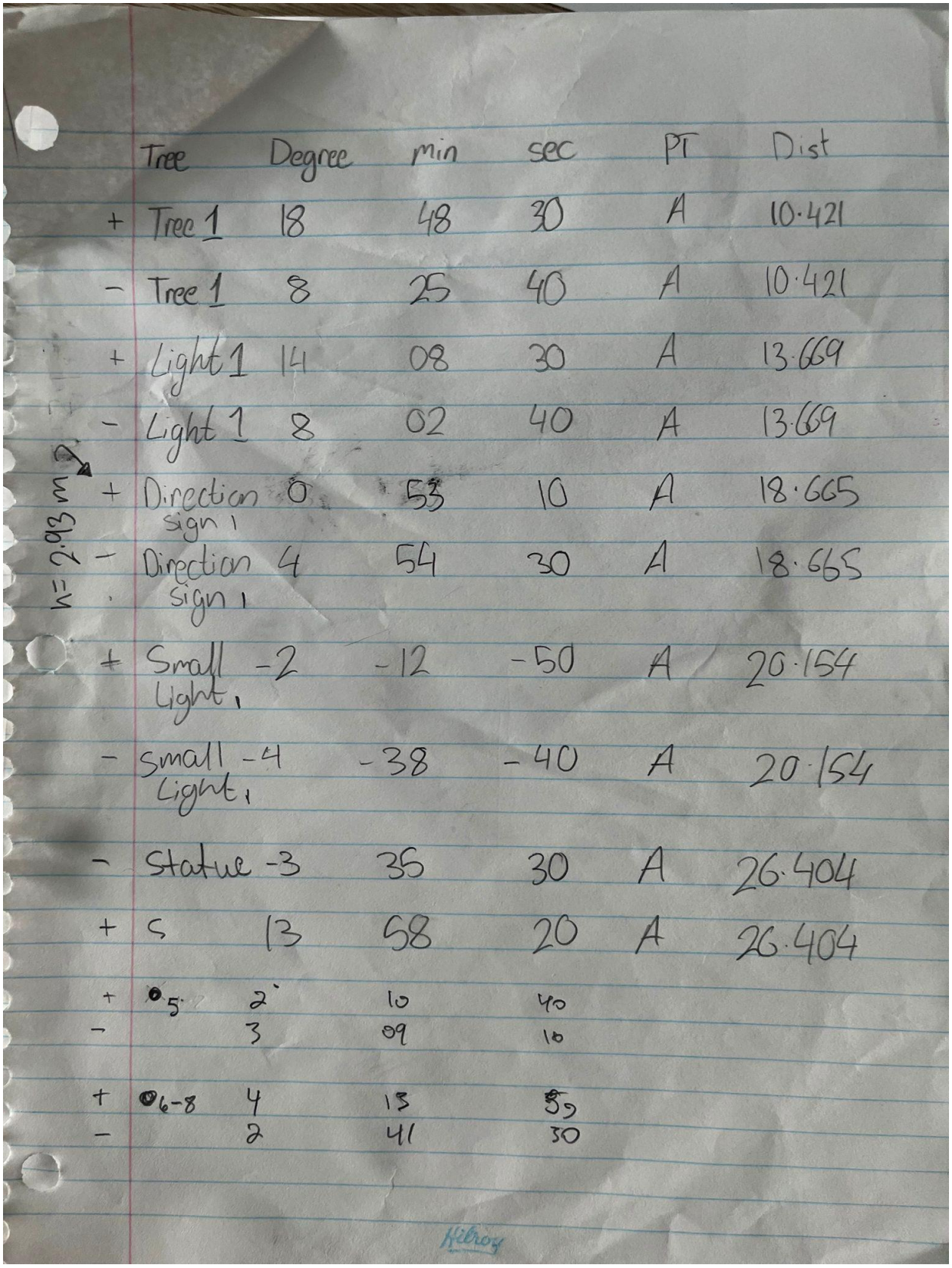
Appendix 9



Appendix 10



Appendix 11



	Tree	Degree	min	sec	PT	Dist
+	Tree 1	18	48	30	A	10.421
−	Tree 1	8	25	40	A	10.421
+	Light 1	14	08	30	A	13.669
−	Light 1	8	02	40	A	13.669
+	Direction sign 1	0	53	10	A	18.665
−	Direction sign 1	4	54	30	A	18.665
+	Small Light 1	-2	-12	-50	A	20.154
−	Small Light 1	-4	-38	-40	A	20.154
−	Statue	-3	35	30	A	26.404
+	S	13	58	20	A	26.404
+	5	2	10	40		
−		3	09	10		
+	6-8	4	13	59		
−		2	41	30		

h = 2.93 m

Appendix 12