

CAD & SURVEY Tools

Training guide

CLABEL · CLEAD · CTRANS · GEOUTM · SREPORT · CCOMP · CROUTE · CDIV · CAREA · ANUM · CVOL · CPROF · CGRID · PTX · OINFO · CPOINTS · CBM · CLEN · CSEL · CNOTE · CSPROFILE · CSCOORD · CSDRAW

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CAD & SURVEY Tools — Training pack

Twenty-one exercises, one for every tool of the ribbon, with real-looking data from the Rumaila / Basra area (UTM zone 38N, WGS 84). Every exercise gives you the files, the steps with the exact button names, the calculation done by hand, and the numbers the tool must show — so you know the tool is right, and you know why.

1 The exercises (in the order of the ribbon)

No.	Tool	What you practise	Folder
01	**CLABEL**	Plot corners: numbers, table, plant system, latitude / longitude	`01_CLABEL/`
02	**CLEAD**	Valve labels along a flowline, a special note and the table	`02_CLEAD/`
03	**CTRANS**	Plant system ↔ UTM: setup, verify, import, move a drawing	`03_CTRANS/`
04	**GEOUTM**	Latitude / longitude ↔ UTM 38N by hand and with the tool, KML	`04_GEOUTM/`
05	**SREPORT**	Anchor bolts design against field, benchmark level check	`05_SREPORT/`
06	**CCOMP**	Design against as-built points: moved, added, deleted	`06_CCOMP/`
07	**CROUTE**	Pipeline route: legs, deflection angles, KP, marks and stakeout	`07_CROUTE/`
08	**CDIV**	Three partners 2 : 1 : 1 and a road deduction	`08_CDIV/`
09	**CAREA**	Areas with an island, an arc side and a small gap	`09_CAREA/`
10	**ANUM**	Fence posts every 25 m, plot numbers, renumbering	`10_ANUM/`
11	**CVOL**	A stockpile of known shape and a platform on flat ground	`11_CVOL/`
12	**CPROF**	Road and pipeline profiles: a level typo, vertical curves, crossings and clearance, sheets	`12_CPROF/`
13	**CGRID**	A 50 m coordinate grid with a second (plant) system	`13_CGRID/`
14	**PTX**	Numbering a polyline, instrument files CSV and Leica GSI-16	`14_PTX/`
15	**OINFO**	Length, bearing, arc and polygon values by hand	`15_OINFO/`
16	**CPOINTS**	Import a field file, bad rows, N before E	`16_CPOINTS/`
17	**CBM**	Benchmarks from points, level texts and a block; latitude / longitude by hand	`17_CBM/`
18	**CLEN**	Lengths of every kind: arc in a polyline, 3D trench, perimeter, by type	`18_CLEN/`
19	**CSEL**	Find by value: plots of about 500 m², 6 m kerbs, Ø 0.60 pipes, levels in a range, no level; Focus, PDF	`19_CSEL/`
20	**CNOTE**	Site notes on a footing, an area and a polygon; photo, voice, a late reminder and its alert; PDF	`20_CNOTE/`
21	**PROFILE**	My Profile: name, instruments with calibration, a project linked at the first save, reports that fill themselves	`21_PROFILE/`
22	**CSCOORD**	One drawing, a plant and two sites with their own systems; Dual Draw with Pick site	`22_CSCOORD/`

2 How to start

1. Copy the whole **Training** folder to a folder of yours (for example Documents). The installed folder may be read-only, and the exercises save files.
2. In AutoCAD or Civil 3D: OPEN, set the file type to **DXF (*.dxf)** and open `<TOOL>_start.dxf` of the exercise. Then SAVEAS it as a DWG in the same folder.
3. If a DXF does not open on your version: start a new metric drawing (acadiso.dwt), type SCRIPT and choose `<TOOL>_start.scr` from the same folder — it draws the same drawing.
4. Used the tool before? Its palette keeps your last settings (next number, prefix, system, spacing...). Press Reset on the palette first, so the numbers match this guide.
5. Keep this guide open next to AutoCAD and follow the steps. Compare every number with the green box **What you should see**.

3 How to read the exercises

Start = a button or a choice of the palette, written in English exactly as on the screen. The yellow one Calculate is the main button of the page.

`37.8` = a value you type.

Worked calculation: the same numbers worked by hand, step by step, so you can check the tool with a calculator.

What you should see: the numbers the tool must show. A difference in the last millimetre (rounding) is normal.

All drawings are in metres; coordinates are UTM zone 38 north (WGS 84) unless the exercise says local (plant) system. Files whose name has **EXPECTED** hold the answers. New to the tools? Start with the free ones: 16 CPOINTS, 15 OINFO, 09 CAREA, 10 ANUM.

01 Super Labels CLABEL PRO

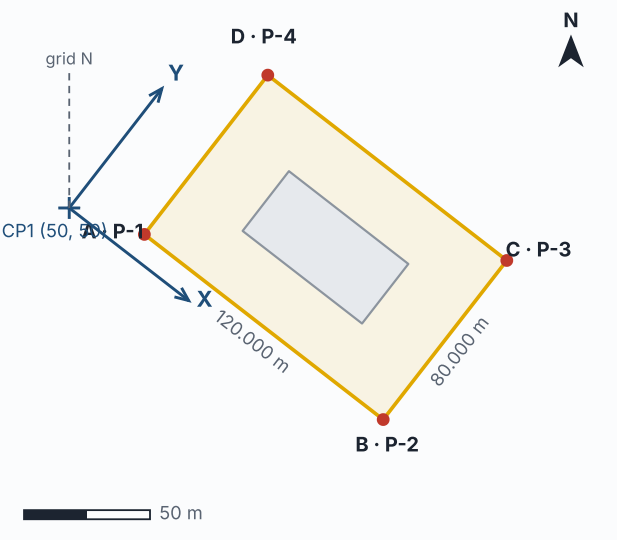
Number the four corners of plot WIP-2 / 7, put their coordinates in a table in UTM and in the plant system at once, and read the latitude / longitude of a corner.

1 Files in the folder

`CLABEL_start.dxf`
the plot (closed polyline A-B-C-D), the pump house and control point CP1, in UTM 38N

`CLABEL_start.scr`
the same drawing as a script (only if the DXF does not open)

`CLABEL_EXPECTED_corners.csv`
the answers: E, N, X, Y, latitude and longitude of A-D



Plot WIP-2 / 7 to scale. The plant axes X, Y turn 37.8° clockwise from grid north (CP1 = local 50, 50).

2 Steps

1. Open `CLABEL_start.dxf` and type **CLABEL** (or press **Super Labels** on the ribbon).
2. Page **System**: tick **Use a second system**, Type **Local**. Under LOCAL SYSTEM choose I have = **Point + rotation** and type Local `50.000` `50.000`, Grid `723215.0214` `3389179.4572`, Rotation `37.8` ° **CW**. Set **Drawing is in** = **GRID**.
3. Page **Select**: OUTPUT = **Number + table**. In the Lines bar keep No, E and N on (Z off). Press **Start**, click the plot fence once, press Enter, then click where the table goes.
4. Compare the table with the green box (also in `CLABEL_EXPECTED_corners.csv`).
5. Back on **System** choose Type **Geographic**, zone `38` **N**, and press **Check the drawing**: it must say the drawing is inside zone 38. Then page **Query**: **Start** and click corner C (Endpoint snap). Read latitude / longitude.

💡 **Floating box:** While picking, press **N**: a small box opens next to the mouse to change the prefix and the next number - Enter and go on. The gold 💡 line in the palette reminds you; **Turn off** × in the box switches it off (the command line asks instead) and **Floating box** in the palette (or BOX) turns it back on.

🆕 **2.4.1 · Update and sites:** labels follow the site a point is in (exercise 22). Linked a site to its system after labelling? Press **Update**, draw a window over the labels (or Enter = all): they are worked out again; a label edited by hand is never touched.

3 Worked calculation by hand

Corner B: from the grid (UTM) to the plant system

1 ΔE = 723339.674 − 723215.0214
ΔN = 3389095.423 − 3389179.4572
ΔE = 124.6526 · ΔN = -84.0342
B relative to CP1, in the grid.

2 c = cos 37.8° = 0.790155
s = +sin 37.8° = 0.612907
CW → s > 0
Clockwise rotation: the sine is positive.

3 X = 50 + ΔE·c − ΔN·s = 50 + 98.4949 + 51.5052
X = 200.000
The reverse formula (grid → local).

4 Y = 50 + ΔE·s + ΔN·c = 50 + 76.4005 + (-66.4000)
Y = 60.000
B is 120 m along X from A: the plot is a clean 120 × 80 m rectangle in the plant system.

Corner C: UTM → latitude / longitude

1 E = 723388.706 N = 3389158.635 zone 38 N
λ0 = 6 × 38 − 183 = 45°
The same Transverse Mercator steps as in exercise 04 (GEOUTM).

2 φ = 30.614177388° λ = 47.330338077°
30°36'51.039"N 47°19'49.217"E
Seconds with 3 decimals (the CLABEL default).

4 What you should see

✓ What you should see

No.	Corner	E	N	X	Y
P-1	A	723244.855	3389168.972	80.000	60.000
P-2	B	723339.674	3389095.423	200.000	60.000
P-3	C	723388.706	3389158.635	200.000	140.000
P-4	D	723293.888	3389232.184	80.000	140.000

Query, corner C (geographic) **30°36'51.039"N 47°19'49.217"E**

Check the drawing **inside zone 38**

5 Common mistakes

- Rotation set to **CCW** instead of **CW**: corner B comes out as X 96.990, Y -92.801 instead of 200.000, 60.000.
- **Drawing is in** left on LOCAL: the tool then treats the UTM numbers as plant numbers and the second column is nonsense.

- Clicking near a corner without Endpoint snap in Query: the numbers differ by centimetres.

6 Check yourself

The pump house corner nearest to A is at plant X 110.000, Y 85.000. What E and N will CLABEL show for it?

Answer: E = 723215.0214 + 60·c + 35·s = 723283.882, N = 3389179.4572 + 35·c − 60·s = 3389170.338 (local → grid formula, c = cos 37.8°, s = sin 37.8°).

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02 Quick Coord CLEAD

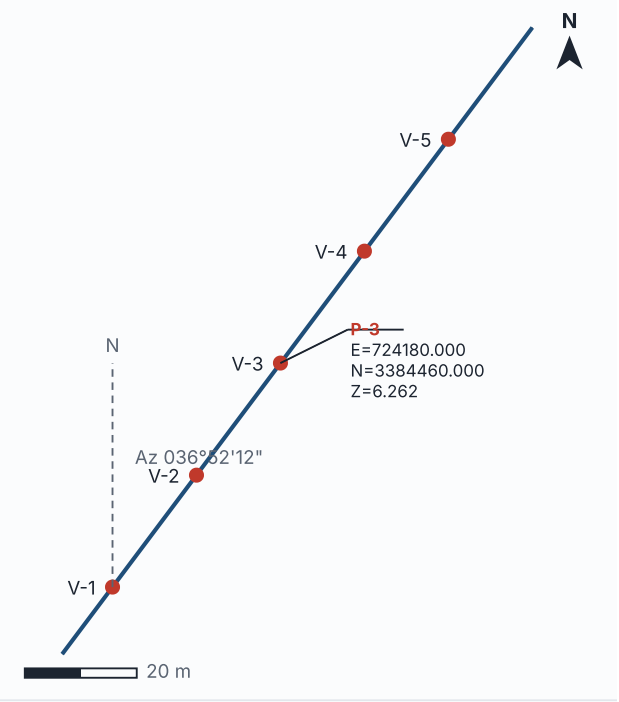
Label the five valves of flowline FL-207 with number, E, N and Z in a few clicks, mark the live part with a special note, and make the table.

1 Files in the folder

`CLEAD_start.dxf`
flowline FL-207 and valves V-1...V-5 as POINT objects at their levels

`CLEAD_start.scr`
the same drawing as a script

`CLEAD_EXPECTED_labels.csv`
the answers: what every label and the table show



Valves every 25 m along FL-207 (to scale) and the label of V-3.

2 Steps

1. Open `CLEAD_start.dxf`, type **CLEAD**: a small bar appears over the drawing.
2. Press ⚙ (settings): Number prefix `P-` and next number `1`, prefixes `E=` `N=` `Z=`, Decimals `3`, Elevation = **From the clicked object**. OK.
3. Make sure N, E, Z are lit on the bar. Press **Pick**, click valve V-1 (Node snap) and drag the leader to a free place. Do the same for V-2 and V-3.
4. V-4 and V-5 are on the live part of the line: in ⚙ turn on **Special note** with `LIVE PIPE` (✓), then label V-4 and V-5. The note is added as one more line in its own colour.
5. Press U once: the last label goes and the number steps back to P-5. Press R (Redo) to bring it back. Then Enter.
6. Press ▦ (table) → **All labels in the drawing** and place the table; or X for Excel.

🆕 **2.4.1 · Update and sites:** labels follow the site a point is in (exercise 22). Linked a site to its system after labelling? Press **Update**, draw a window over the labels (or Enter = all): they are worked out again; a label edited by hand is never touched.

3 Worked calculation by hand

Where valve V-3 must be (25 m spacing, azimuth from V-1 to V-5)

1 ΔE = 724210.000 − 724150.000 = 60.000
ΔN = 3384500.000 − 3384420.000 = 80.000
L = √(60² + 80²) = 100.000 m
V-1 to V-5 = 4 × 25 m.

2 Az = atan(ΔE / ΔN) = atan(60 / 80) = 36.8699°
Az = 036°52'12"
North-east quarter: the angle is the azimuth.

3 sin Az = 60/100 = 0.6 cos Az = 80/100 = 0.8
sin 0.6 · cos 0.8
A 3-4-5 direction: exact numbers.

4 E(V-3) = 724150.000 + 50 × 0.6
N(V-3) = 3384420.000 + 50 × 0.8
E = 724180.000 · N = 3384460.000
The label of V-3 must show exactly these values.

4 What you should see

✓ **What you should see**

No.	Valve	d (m)	E	N	Z	Note
P-1	V-1	0	724150.000	3384420.000	6.215	
P-2	V-2	25	724165.000	3384440.000	6.240	
P-3	V-3	50	724180.000	3384460.000	6.262	
P-4	V-4	75	724195.000	3384480.000	6.291	LIVE PIPE
P-5	V-5	100	724210.000	3384500.000	6.318	LIVE PIPE

After U (undo) the next number is **P-5**

Table rows (sorted by number) **P-1 … P-5**

Layer of the labels **COORD-LEADER**

5 Common mistakes

- Clicking the circle drawn around a valve instead of the POINT (Node snap): Z then comes from the circle (0.000).
- Elevation left on a fixed value: every label shows the same Z.
- Forgetting to turn the special note off: the next labels keep LIVE PIPE.

6 Check yourself

A sixth valve V-6 is 125 m from V-1 on the same line. What will its label show for E and N?

Answer: E = 724150 + 125 × 0.6 = 724225.000, N = 3384420 + 125 × 0.8 = 3384520.000.

03 Coord Transform CTRANS PRO

Set up the plant system of the Rumaila plant (one known point and a 37.8° rotation), prove it on control points, bring 20 local points to UTM, and move the plant drawing to the local system.

1 Files in the folder

`CTRANS_start.dxf`
the plant in GRID (UTM 38N): fence, tank, pump house, CP1... CP6

`CTRANS_verify_paste_tab.txt`
the 6 control points, ready to paste on Verify

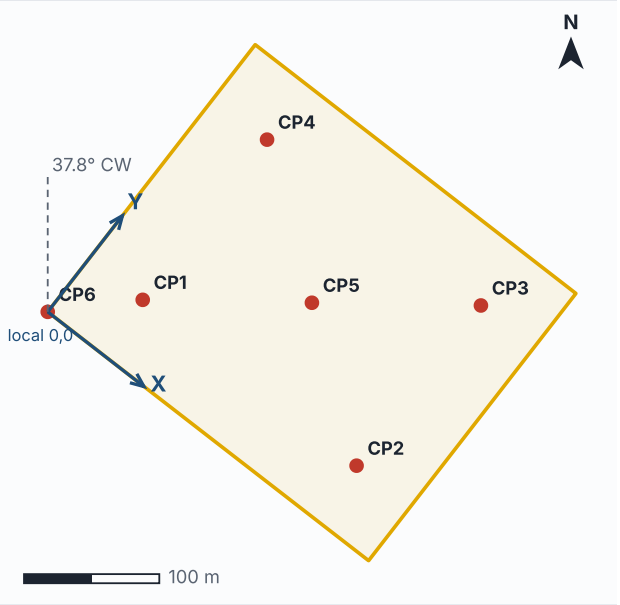
`CTRANS_control_points_local_grid.csv`
the same control points with a header (X, Y, E, N)

`CTRANS_Project_PointRotation.ctrans`
project: point + rotation, 5 verify points (one 25 mm wrong)

`CTRANS_Project_TwoPoints.ctrans`
project: two points, the rotation is calculated

`CTRANS_points_local_to_grid.csv`
20 site points L1...L20 in the plant system

`CTRANS_points_local_to_grid_EXPECTED.csv`
the answers in UTM



The plant fence in UTM (to scale): local X, Y axes from (0, 0) = CP6, turned 37.8° clockwise.

2 Steps

1. Open `CTRANS_start.dxf` and type **CTRANS**. Page **Setup**: I HAVE = **Point + rotation**; Local `50.000` `50.000`; Grid `723215.0214` `3389179.4572`; Rotation `37.8` ° **CW**; **Drawing is in** = **GRID**.
2. Read the summary line (calculation A).
3. Page **Verify**: open `CTRANS_verify_paste_tab.txt` in Notepad, Ctrl+A, Ctrl+C, then **Paste**. Tolerance `0.010` m, press **Check**.
4. Page **Setup** → **File...** (open project) → `CTRANS_Project_PointRotation.ctrans`, then **Verify** → **Check**: one point fails on purpose. Open `CTRANS_Project_TwoPoints.ctrans` the same way and look at the calculated rotation (calculation C).
5. Page **Import** → **File...** → `CTRANS_points_local_to_grid.csv`; **Table is in** = **LOCAL**, **Drawing is in** = **GRID**; tick Points, Labels, Zoom; press **Import**.
6. Back on **Setup** (Point + rotation again): Direction **GRID → LOCAL**, Mode **New drawing**, press **Transform** and select the fence, the tank and the pump house. In the new drawing check with ID that the fence corners are (0, 0), (300, 0), (300, 250), (0, 250).

3 Worked calculation by hand

A) Setup: where the local origin (0, 0) lands = the summary line

1 `c = cos 37.8° = 0.790155  s = +sin 37.8° = 0.612907`
`CW → s > 0`

2 `E0 = 723215.0214 − (50·c + 50·s) = 723215.0214 − 70.1531`
`Shift E +723144.868`
ΔX = ΔY = −50 from the known point to (0, 0).

3 `N0 = 3389179.4572 − (50·c − 50·s) = 3389179.4572 − 8.8624`
`Shift N +3389170.595 · Rot 37.8° CW`
Exactly the summary line of the Setup page.

B) Import: point L1 from local to grid

1 `ΔX = 52.214 − 50 = 2.214  ΔY = 47.391 − 50 = -2.609`
`ΔX 2.214 · ΔY -2.609`

2 `E = 723215.0214 + ΔX·c + ΔY·s = 723215.0214 + 1.7494 + (-1.5991)`
`E = 723215.172`

3 `N = 3389179.4572 + ΔY·c − ΔX·s = 3389179.4572 + (-2.0615) − 1.3570`
`N = 3389176.039`
Same as the EXPECTED file.

C) Two points CP2, CP3: the rotation is calculated

1 `αL = atan2(200 − 50, 250 − 250) = atan2(150, 0)`
`αL = 90.000000°`
In the plant system CP2 → CP3 runs along +Y.

2 `αG = atan2(3389175.3990 − 3389056.8758, 723464.9885 − 723373.0524)`
`αG = 52.199975°`

3 `θ = αL − αG ;  dL = 150.000  dG = 150.0000`
`θ = 37.800025° CW`
Positive = CW. The extra 0.000025° comes from the 4-decimal coordinates; the distances agree (scale 1).

4 `CP5_BAD: d = √((723340.0299 − 723340.0049)² + 0²)`
`d = 0.025 m > 0.010 → FAIL`
The verify point typed 25 mm wrong in E.

4 What you should see

✓ What you should see

Summary line	**Shift E +723144.868, N +3389170.595 · Rot 37.8° CW**
Verify (pasted 6 points)	**6 PASS (0.000–0.001 m)**
Project PointRotation → Check	**4 PASS · 1 FAIL (CP5_BAD 0.025 m)**
Project TwoPoints: rotation	**37.800025° CW · 150.000 = 150.000**
Import: 20 points	**L1 → 723215.172, 3389176.039**

Point	X	Y	E	N
L1	52.214	47.391	723215.172	3389176.039
L2	89.689	47.178	723244.652	3389152.902
L3	131.752	52.253	723280.999	3389131.131
L4	169.940	50.306	723309.980	3389106.187

5 Common mistakes

- Typing the rotation as CCW: all 6 verify points fail by tens of metres — Verify catches it at once.
- Import with **Table is in** = GRID for a local file: the points land near 0,0, far from the plant.
- Using **Move** when unsure: it changes the original objects. Use **Copy** or **New drawing**.

6 Check yourself

The fence corner at local (300, 250): what are its E and N?

Answer: ΔX = 250, ΔY = 200: E = 723215.0214 + 250c + 200s = 723535.142, N = 3389179.4572 + 200c − 250s = 3389184.261.

04 Geo ↔ UTM GEOUTM PRO

Convert a Basra point from latitude / longitude to UTM 38N by hand and with the tool, read the wells of a lease, import a GPS list and send the lease to Google Earth.

1 Files in the folder

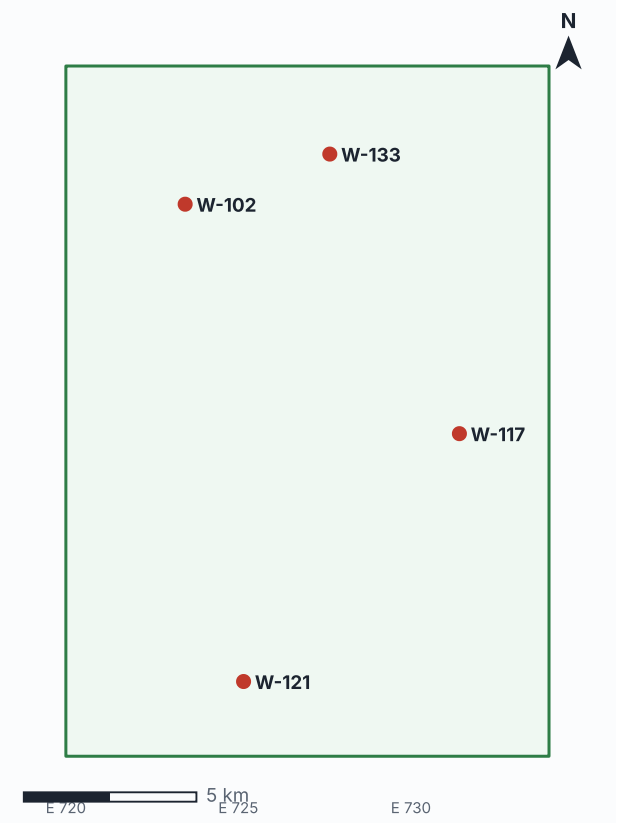
`GEOUTM_start.dxf`
four wells (POINT) and the lease polygon in UTM 38N

`GEOUTM_geo_DD.csv`
10 points in decimal degrees

`GEOUTM_geo_DMS_symbols.csv`
the same 10 points in D°M'S"

`GEOUTM_utm_to_geo.csv`
the same points in UTM, for the way back

`GEOUTM_EXPECTED_answers.csv`
the answers (E/N and DMS of all 10)



The lease and the four wells to scale (UTM 38N).

2 Steps

1. Type **GEOUTM**. Page **Convert**: type Latitude `30 30 00` and Longitude `47 48 00`, press **To UTM**.
2. Open `GEOUTM_start.dxf`. Page **Query**: **Start** and click the four wells (Node snap). Compare the list with the table on the right.
3. Page **Import**: **File...** → `GEOUTM_geo_DD.csv`. Check the columns (Lat, Lon, H, Desc) and the angle mode in the preview, then **Draw**. G03 must land at E 731401.829 N 3382346.270 (= well W-117).
4. Do the same with `GEOUTM_geo_DMS_symbols.csv`: the DMS text gives the same points (±3 mm from the 4-decimal seconds).
5. Page **KML**: press **KML** and select the lease polygon and the wells; open the file in Google Earth.

3 Worked calculation by hand

Point G01 (Basra): φ = 30.5° N, λ = 47.8° E → UTM 38N

1 `zone = floor((47.8 + 180) / 6) + 1 = 38  λ0 = 6·38 − 183 = 45°`
`Δλ = 2.8° = 0.0488692191 rad`
The zone and its central meridian.

2 $\tau = \tan\varphi = 0.5890450164$
$\sigma = \sinh(e \cdot \operatorname{atanh}(e \cdot \tau/\sqrt{(1+\tau^2)})) = 0.0033996163$
$\tau' = \tau\sqrt{(1+\sigma^2)} - \sigma\sqrt{(1+\tau^2)}$
$\tau' = 0.5851028525$ ($\chi = 30.33202441°$)
Conformal latitude χ.

3 $\xi' = \operatorname{atan2}(\tau', \cos\Delta\lambda)$
$\eta' = \operatorname{asinh}(\sin\Delta\lambda / \sqrt{\tau'^2 + \cos^2\Delta\lambda})$
$\xi' = 0.5299145399$ · $\eta' = 0.0421879030$
Transverse Mercator on the sphere.

4 $\xi = \xi' + \Sigma\ \alpha j \sin(2j\xi')\cosh(2j\eta')$
$\eta = \eta' + \Sigma\ \alpha j \cos(2j\xi')\sinh(2j\eta')$ $(j = 1\ldots4)$
first terms × k0·A: +4667.590 / +220.271 m
$\xi = 0.5306485309$ · $\eta = 0.0422224425$
Krüger series back to the ellipsoid.

5 $E = 500000 + k0 \cdot A \cdot \eta = 500000 + 6364902.166 \times 0.0422224425$
$N = k0 \cdot A \cdot \xi$
E = 768741.716 · N = 3377525.984
k0·A = 6 364 902.166 m. Same as the help and the EXPECTED file.

Well W-102 = G02: decimal degrees ↔ D° M' S"

1 $t = \text{round}(30.612734329 \times 3600, 4)$
t = 110205.8436″
Everything to seconds, rounded once.

2 $D = \text{floor}(t / 3600) = 30$; $\text{rest} = 2205.8436$
$M = \text{floor}(\text{rest} / 60) = 36$; $S = \text{rest} - 2160$
30°36'45.8436"N

3 $DD = 30 + 36/60 + 45.8436/3600$
30.6127343°
Back again: the 0.00004″ difference ≈ 1 mm.

4 What you should see

✓ What you should see

Convert G01 → To UTM — **E 768741.716 N 3377525.984 (38 N)**

Well	E	N	Latitude	Longitude
W-102	723457.000	3389000.000	30°36'45.8436"N	47°19'51.6566"E
W-117	731401.829	3382346.270	30°33'04.4444"N	47°24'44.4444"E
W-121	725151.749	3375162.538	30°29'15.5556"N	47°20'44.4440"E
W-133	727645.877	3390448.083	30°37'30.0000"N	47°22'30.0000"E

5 Common mistakes

- Longitude and latitude swapped (47.8, 30.5): the point jumps to another zone and the tool warns it is far outside.
- Drawing zone not 38: every latitude / longitude is wrong. Zone 38 covers 42°–48° E.
- Reading "30 36.764" as degrees-minutes-seconds: it is degrees and decimal minutes (D M).

6 Check yourself

A GPS gives 30°37'30"N 47°22'30"E. Which well of the drawing is it, and what is its E?

Answer: Well W-133 (G10): E 727645.877, N 3390448.083.

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05 Survey Report SREPORT PRO

Check 24 anchor bolts of six pedestals against the field survey with pass / fail by tolerance, and check the benchmark levels of the site before the work.

1 Files in the folder

`SREPORT_start.dxf`
pedestals PD-1...PD-6 with the 24 design bolts

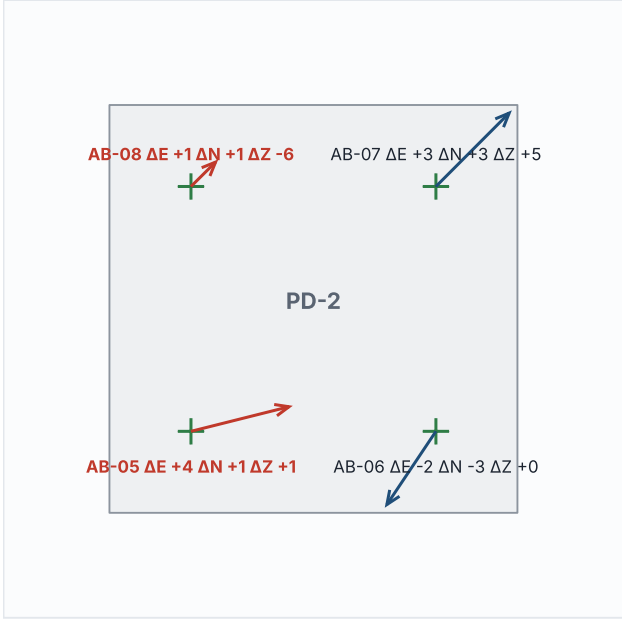
`SREPORT_General_design_anchor_bolts.csv`
design bolts AB-01...AB-24

`SREPORT_General_field_anchor_bolts.csv`
field survey: 23 bolts + extra shot 199

`SREPORT_BM_Level_known.csv`
published benchmark levels and distances

`SREPORT_BM_Level_measured.csv`
your measured levels (BM-05 not measured)

`SREPORT_BM_LevelRun_fieldbook.csv`
the level book BS / FS of the loop



Pedestal PD-2: design bolts (+) and the field shift drawn 30 times bigger; red = FAIL at ±3 mm.

2 Steps

1. Open `SREPORT_start.dxf`, type **SREPORT**, tab **General**. Fill **Project info** once (project, instrument).
2. DESIGN: **File...** → **Design points P, E, N, Z, Desc** → `SREPORT_General_design_anchor_bolts.csv` (24 rows). FIELD: **File...** → **Field points P, E, N, Z, Desc** → `SREPORT_General_field_anchor_bolts.csv`.
3. CHECK: E/N ± `3` mm, Z ± `5` mm, **Auto search** on. Press **Match**, then **Draw result** (arrows and colours on the pedestals).
4. Change E/N to `5` and press **Match** again: only two bolts still fail. Then **PDF** for the A4 report.
5. Tab **BM / CP**, Check = **Level**. **File...** → **Known points P, Z, Dist** → `SREPORT_BM_Level_known.csv`; **File...** → **Measured points P, Z** → `SREPORT_BM_Level_measured.csv`. V ± `10` mm, Closure `4` mm, C = `12`, rule × √K.

💡 **Floating box:** While picking the design points (Pick in DWG, General), type **Z** for the design level or **D** for the description: a small box opens next to the mouse. The gold 💡 line in the palette reminds you; **Turn off** × in the box switches it off (the command line asks instead) and **Floating box** in the palette (or BOX) turns it back on.

🆕 **2.4.1 · Report No. Auto:** tick **Auto** next to Report No. and type the first number once, e.g. `RBT-2PA-001`: the next report you export takes `RBT-2PA-002` by itself (a re-export of the same data keeps its number). Untick it to type the number by hand. **Signature:** when Prepared by is your My Profile name, your saved signature goes into the signature box of the PDF.

3 Worked calculation by hand

Anchor bolt AB-05 (pedestal PD-2)

1

```
design 722655.850  3375499.850  10.150
field  722655.854  3375499.851  10.151   (point 105)
```

nearest design within the search

Auto search = half the shortest design spacing = 0.300 / 2 = 0.150 m.

2

```
ΔE = (722655.854 − 722655.850) × 1000
ΔN = (3375499.851 − 3375499.850) × 1000
ΔZ = (10.151 − 10.150) × 1000
```

ΔE +4 · ΔN +1 · ΔZ +1 mm

Field minus design, rounded to whole mm.

3

```
|+4| > 3  →  E fails ;  at ±5: 4 ≤ 5
```

FAIL at ±3 mm · PASS at ±5 mm

Each difference is checked by itself; one bad value is enough.

4

```
pass rate = 17 / 23 × 100
```

73.9 %

23 matched bolts; AB-24 is missing, 199 has no design.

Benchmark level loop: closure and allowed value

1

```
ΣBS − ΣFS = 11.608 − 11.604
```

+0.004 m = 4 mm

From the field book (closed loop BM-01 → … → BM-01).

2

```
K = (180 + 200 + 180) / 1000 = 0.560 km
allowed = 12 × √0.560
```

allowed = 9.0 mm ≥ 4 → OK

K comes from the Dist column of the known file. With the whole loop (0.710 km): 10.1 mm, still OK.

3

```
BM-03: (11.047 − 11.035) × 1000 = +12
```

|+12| > 10 → FAIL

4

```
BM-05: no measurement
```

MISSING → NOT ACCEPTED

A known point that was not measured stops the acceptance.

4 What you should see

✓ What you should see

Match at E/N ±3, Z ±5	**Matched 23 · PASS 17 · FAIL 6**
Missing / no design	**AB-24 MISSING · 199 NO DESIGN**
At E/N ±5	**PASS 21 · FAIL 2 (AB-08, AB-21)**

Design	Field	ΔE	ΔN	ΔZ	±3 / ±5
AB-05	105	+4	+1	+1	**FAIL**
AB-08	108	+1	+1	-6	**FAIL**
AB-11	111	+2	-4	-1	**FAIL**
AB-13	113	+5	+0	+2	**FAIL**
AB-19	119	-4	-2	+1	**FAIL**
AB-21	121	+0	+0	+7	**FAIL**

BM-01 · BM-02 · BM-03 · TBM-04	**+0 · −4 · +12 FAIL · +9**
Closure	**4 mm ≤ 9.0 mm OK**
Result	**NOT ACCEPTED (BM-05 MISSING)**

5 Common mistakes

- Field file chosen with the wrong order (P, N, E): the points land far away — the tool asks **Swap E and N?**: answer Yes.
- **Auto search** turned off with a small search: bolts become NO DESIGN instead of FAIL.
- Typing the closure in metres (0.004) instead of mm (4).

6 Check yourself

Bolt AB-13 is off ΔE +5, ΔN 0, ΔZ +2 mm. Does it pass at ±3 mm? At ±5 mm?

Answer: FAIL at ±3 (5 > 3), PASS at ±5 (equal to the tolerance is a pass).

06 DWG Compare CCOMP

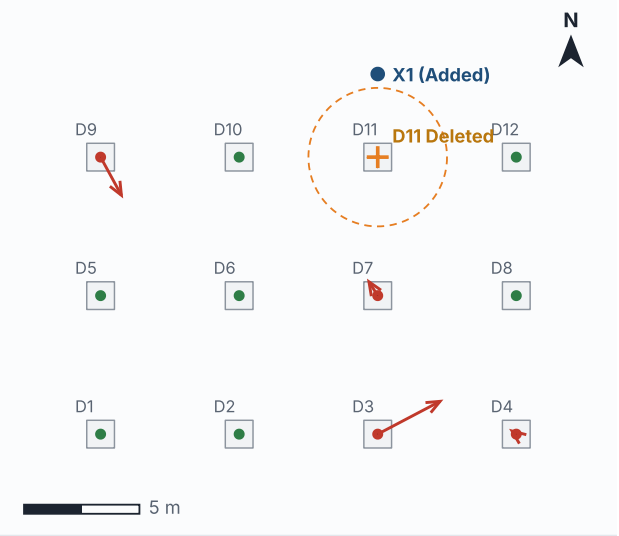
Compare 12 design foundation centres with the as-built survey in the same drawing, and find what moved, what is missing and what is new.

1 Files in the folder

`CCOMP_start.dxf`
layer DESIGN (12 points) and layer ASBUILT (survey), POINT objects

`CCOMP_design_and_asbuilt.csv`
the coordinates of both layers

`CCOMP_EXPECTED_result.csv`
the answers: result of every point



Foundations on a 6 m grid; red arrows = moves drawn 15 times bigger; dashed circle = search 3.000 m.

2 Steps

1. Open `CCOMP_start.dxf`, type **CCOMP**. SOURCE **Same drawing**, SETS **By layer**: A = `DESIGN`, B = `ASBUILT` (type or pick an object).
2. Area & tolerance: **Whole**, Tol `0.010`, Search `auto`. Objects: **Points** only. Press **Compare**.
3. Click the count **Moved**: the list starts with the biggest move. Click a row to zoom to it.
4. Type Search `4` and Compare again: X1 now pairs with D11 (Moved 3.600) — think whether that is true on site.
5. Back to `auto`, Compare, then **Table** or **PDF** for the report. **Clear** removes the colours.

3 Worked calculation by hand

From matching to the result (tolerance 0.010 m, search auto)

1. `nearest spacing of the design points = 6.000 m (all 12)`
   `r = 6.000 / 2`
   `Search (auto) = 3.000 m`
   Half of the small spacing (the lowest 10 % of the nearest-neighbour distances).

2. `D3: Shift = √(0.180² + 0.095²) = √(0.032400 + 0.009025)`
   `0.204 > 0.010 → Moved`
   dE, dN = as-built minus design.

3. `D4: √((−0.012)² + 0.009²) = √(0.000144 + 0.000081)`
   `0.015 > 0.010 → Moved`
   Even 5 mm over the tolerance is a move.

4 D6: √(0.007² + (−0.007)²) = √0.000098
0.0099 ≤ 0.010 → Same

5 D5: shift 0.000, dZ = 10.165 − 10.150 = +0.015 > 0.010
Same · note "dZ +0.015"
The level difference goes in the note, not in the shift.

6 X1 ↔ D11: √(0.000² + 3.600²) = 3.600 > 3.000
D11 Deleted · X1 Added
Further than the search: no pair.

4 What you should see

✓ **What you should see**

RESULT **4 Moved · 1 Added · 1 Deleted · 7 Same**

Pt	Result	ΔE	ΔN	Shift	Note
D3	Moved	+0.180	+0.095	0.204	
D9	Moved	+0.060	-0.110	0.125	
D7	Moved	-0.025	+0.040	0.047	
D4	Moved	-0.012	+0.009	0.015	
D5	Same	+0.000	+0.000	0.000	dZ +0.015
D12	Same	+0.001	-0.002	0.002	
D8	Same	+0.003	+0.003	0.004	
D1	Same	+0.004	-0.003	0.005	
D2	Same	+0.002	+0.006	0.006	
D10	Same	-0.006	-0.007	0.009	
D6	Same	+0.007	-0.007	0.010	

5 Common mistakes

- Leaving Objects on Texts too: the D1...D12 texts are on another layer, but texts on A or B layers would be compared as well.
- Tolerance typed in mm (10) instead of metres (0.010): everything becomes Same.
- A big Search to "find everything": far points pair wrongly. Keep auto unless a real big move is expected.

6 Check yourself

If the tolerance were 0.020 m, how many points would be Moved?

Answer: 3 (D3 0.204, D9 0.125, D7 0.047); D4 (0.015) becomes Same.

07 Pipeline Survey CROUTE PRO

Read a route table, check every bend angle and chainage by hand, draw flowline FL-123 and check the points the crew staked.

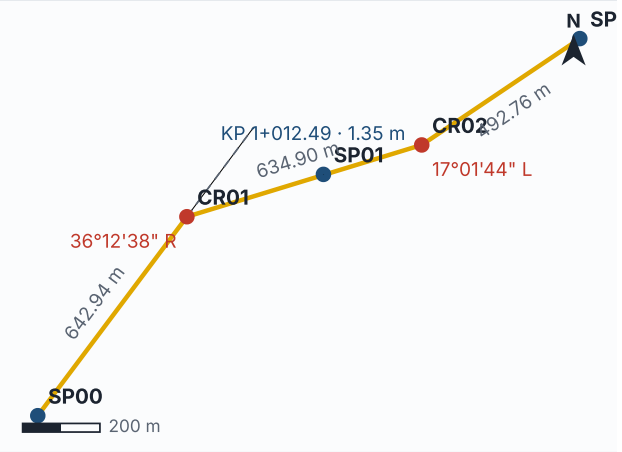
1 Files in the folder

`CROUTE_start.dxf`
road, existing pipe, culvert, OHL, track and manifold along FL-123

`CROUTE_help_example.csv`
5-point example route (worked by hand here)

`CROUTE_FL-123_flowline_route.csv`
the FL-123 route table (21 rows)

`CROUTE_staked_points.csv`
points staked by the crew + stray X99



The example route to scale: legs, deflections, and mark SP01 (offset drawn as it is).

2 Steps

1. Open `CROUTE_start.dxf`, type **CROUTE**. Page **1 Import** → **Excel / CSV...** → `CROUTE_help_example.csv`. The **2 Review** page opens.
2. Compare KP, legs and angles with calculation 1: CR01 ✓, CR02 ≈ (gold), SP01 a mark 1.35 m from the route.
3. Now the real job: **Excel / CSV...** again with `CROUTE_FL-123_flowline_route.csv` (21 rows). No red rows are expected. Page **3 Draw** → **Draw route**: the route runs through the road, pipe, culvert, OHL and track of the drawing.
4. Page **4 Stakeout**: Route points, whole route, **Make list**, then **Import staked...** → `CROUTE_staked_points.csv` with ± `50` mm.

3 Worked calculation by hand

Legs, azimuths and deflection angles (CROUTE_help_example.csv)

1. SP00 → CR01: ΔE = 385.380 ΔN = 514.635
   L = √(ΔE² + ΔN²) ; Az = atan2(ΔE, ΔN)
   L = 642.94 m · Az = 036°49'39"

2. CR01 → CR02: ΔE = 607.280 ΔN = 185.225
   L = 634.90 m · Az = 073°02'16"

3. CR02 → SP02: ΔE = 408.560 ΔN = 275.485
   L = 492.76 m · Az = 056°00'32"

4 CR01: θ = 73.0379° − 36.8274°
CR02: θ = 56.0089° − 73.0379°
+36°12'38" R · −17°01'44" L
Deflection = azimuth out − azimuth in; plus = right. Table 36°13' R → ✓; table 20° L is 2°58' off → ≈ (gold).

5 KP: 0 → 642.94 → 642.94 + 634.90 = 1277.84 → + 492.76
length = 1+770.60
Added unrounded, rounded only for display.

6 SP01 on leg CR01→CR02: t = ((E−E1)ΔE + (N−N1)ΔN) / L² = 0.582061
KP = 642.94 + t × 634.90 ; off = |SP01 − foot|
KP 1+012.49 · 1.35 m
A mark: it gets a KP and its distance from the route.

Stakeout check (tolerance ±50 mm)

1 CR03: dE = +61 mm, dN = +22 mm
dH = √(61² + 22²)
dH = 64.8 mm > 50 → OUT

2 CR09: dE = +40 mm, dN = +31 mm
dH = √(40² + 31²)
dH = 50.6 mm > 50 → OUT
Just over: still out.

4 What you should see

✓ What you should see

Help example	**Length 1770.60 · CR01 0+642.94 ✓ · CR02 1+277.84 ≈ · SP01 1+012.49 / 1.35 m**
FL-123	**12 route points · 10 bends · LENGTH 6907.51 m**
FL-123 marks	**SP01 0+410.00 / 1.20 · SP04 4+420.00 / 2.40 · FS01 6+872.51 / 18.00**
Stakeout	**12 matched · 10 OK · 2 OUT (CR03 64.8, CR09 50.6) · X99 not matched**

5 Common mistakes

- Angles in the table are interior (180° − deflection): the tool finds that by itself; do not "fix" them by hand.
- Taking an SP crossing mark as a route point: SPs between the CRs are marks, only the first and last SP close the route.
- E and N swapped in the table: press **Swap E/N** on the Review page.

6 Check yourself

A peg 5 m right of the route at a bend of 30°: how far from the CR point is it set?

Answer: 5 ÷ cos(15°) = 5.18 m, on the bisector of the bend.

08 Land Subdivision CDIV

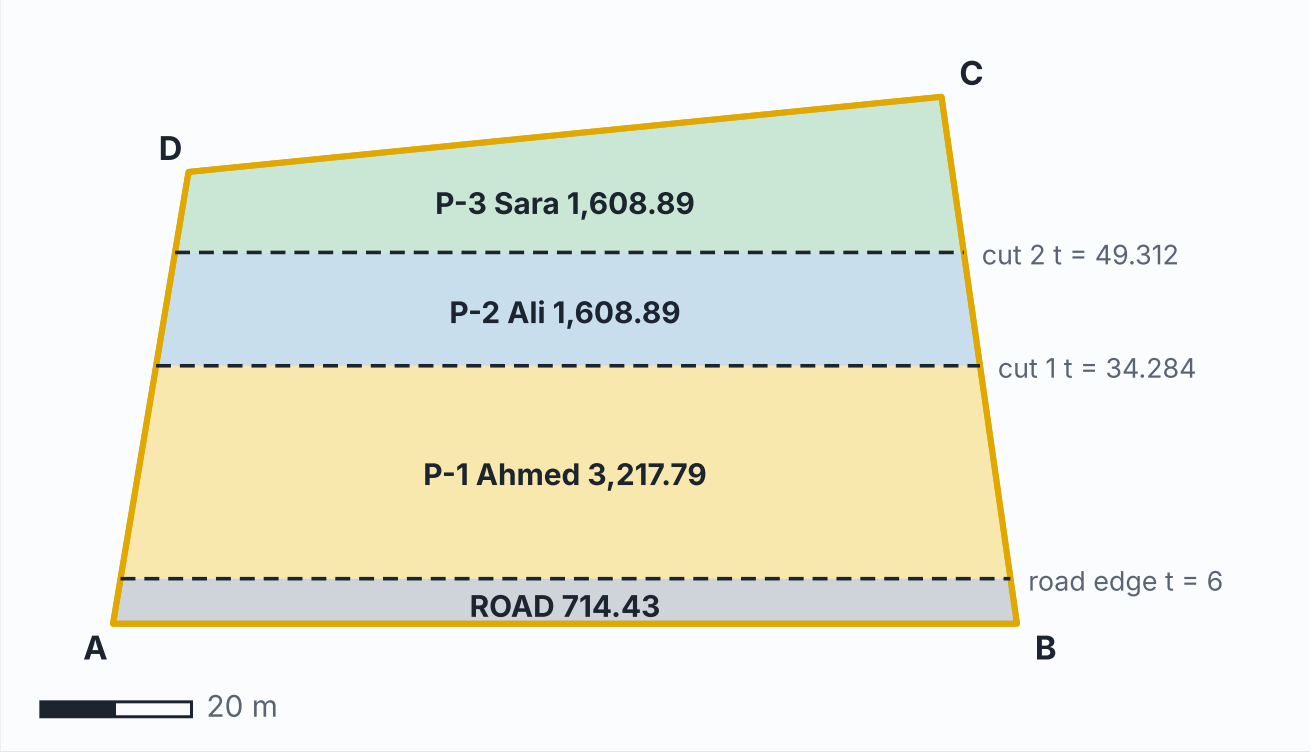
Share land between three partners 2 : 1 : 1 (Ahmed paid half) on two parcels — one rectangular on a street, one irregular — with and without a road deduction, and prove every area by hand.

1 Files in the folder

`CDIV_start.dxf`
parcel 1 (150 × 50, turned) and parcel 2 (A-B-C-D) as closed polylines

`CDIV_parcel_150x50_turned.csv`
corners of parcel 1

`CDIV_parcel_help_example_ABCD.csv`
corners of parcel 2



Parcel 2 to scale: road 6 m, then the cuts parallel to A-B (t = distance from A-B).

2 Steps

1. Open `CDIV_start.dxf` and type **CDIV**. **Select parcel** → click parcel 1 (150 × 50). It shows 7,500.00 m² · 3.000 dunam.
2. METHOD **Parallel to a side**, **Pick side** and click near side A-B (the street): ✓ side picked (150.00 m). SHARES **By ratio** `2 : 1 : 1`, Names `Ahmed, Ali, Sara`. **Preview**, then **Apply**.
3. **Undo**, then on parcel 1 again: Deductions → Road, **Side** on A-B, width `8`; METHOD **Perpendicular to a side** on A-B; SHARES **Equal parts** `3`. Apply.
4. Parcel 2 (A-B-C-D): Parallel to A-B, By ratio 2 : 1 : 1, Ahmed, Ali, Sara, Road on A-B `6` m. Check the cut lengths against calculation 1, then **Table**, **PDF**.

3 Worked calculation by hand

Parcel 2 (A-B-C-D): area, road and shares

1 `local = E − 725000, N − 3390000 → A(0,0) B(120,0) C(110,70) D(10,60)`

same area, smaller numbers

A shift does not change an area: subtract a round origin before the shoelace.

2 `A = ½ |Σ (xi·yi+1 − xi+1·yi)| = ½ |0 + 8400 + 5900 + 0|`

A = 7,150.00 m² = 2.860 dunam

Shoelace (Gauss); 1 dunam = 2,500 m².

3 `road 6 m along A-B: width at t=6 = (120 − 6/7) − 6/6 = 118.14`

`Road = (120.00 + 118.14) / 2 × 6`

Road = 714.43 m² · Net = 6,435.57 m²

A trapezoid strip.

4 `2 + 1 + 1 = 4 ; P-1 = 6435.57 × 2/4 ; P-2 = P-3 = 6435.57 × 1/4`

P-1 3,217.79 · P-2 1,608.89 · P-3 1,608.89

5 `A(t) = 120·t − 13·t²/84 ; A(t1) = 714.43 + 3217.79 = 3932.21`

`t1 = (120 − √(120² − 4·(13/84)·3932.21)) / (2·13/84)`

t1 = 34.284 m · cut 1 = 109.39 m

The tool finds it by halving (bisection); the quadratic gives the same here.

6 `A(t2) = 3932.21 + 1608.89 = 5541.11 → t2`

t2 = 49.312 m · cut 2 = 104.74 m

P-3 takes the rest; CHECK = 0.000 m².

4 What you should see

✓ What you should see

Case	Result
Parcel 1 · Parallel A-B · 2:1:1	P-1 3,750.00 (150 × 25) · P-2 1,875.00 · P-3 1,875.00 · CHECK 0.000
Parcel 1 · road 8 m · 3 equal	Road 1,200.00 · Net 6,300.00 · 3 × 2,100.00
Parcel 2 · road 6 m · 2:1:1	Road 714.43 · 3,217.79 · 1,608.89 · 1,608.89
Parcel 2 · cuts	cut 1 = 109.39 m · cut 2 = 104.74 m
Parcel 2 · without the road	3,575.00 · 1,787.50 · 1,787.50

5 Common mistakes

- Picking the wrong side: the first plot then starts at C-D, not at the street.
- Typing 2:1:1 with **Equal parts** instead of **By ratio**: three plots of equal area.
- Arabic names in the PDF: the PDF prints Latin letters only; Arabic names go to the Excel file.

6 Check yourself

Parcel 1 with an 8 m road along A-B, shared 2 : 1 : 1 (parallel): what is P-1?

Answer: Net = 7,500 − 150 × 8 = 6,300 m²; P-1 = 6,300 × 2/4 = 3,150.00 m² (a 150 × 21 m strip).

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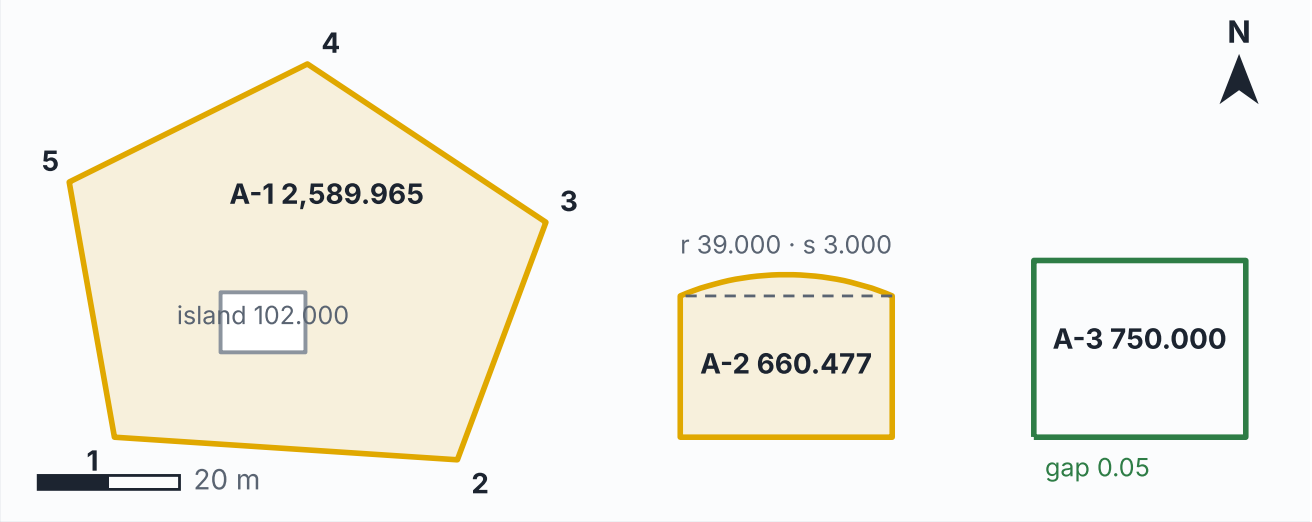
09 Area Calc CAREA

Get three areas the way they come on site: a plot with a building inside, a lot with a curved front and a yard drawn with a small gap — and prove each by hand.

1 Files in the folder

`CAREA_start.dxf`
plot 1 (lines) with the store, lot 2 (arc side), yard 3 (open polyline)

`CAREA_start.scr`
the same drawing as a script



The three areas to scale. Dashed = the chord of the arc.

2 Steps

1. Open `CAREA_start.dxf` and type **CAREA**: the small bar appears. Unit **m²**, gap `0.10`, Label and Hatch on.
2. **Pick inside** and click inside plot 1, outside the store: the store is taken away (1 island).
3. **Select** and click lot 2, then yard 3 (it is open by 5 cm), Enter.
4. Open ☰ (session list), then ▦ for the AutoCAD table. Click **m²** on the unit: lot 2 shows 0.264 dunam.

3 Worked calculation by hand

Plot 1 by the shoelace formula (local numbers = E − 724500, N − 3385500)

1
```
1→2: 0·(−3.2) − 48.5·0 = 0
2→3: 48.5·30.4 − 61.0·(−3.2) = 1669.60
3→4: 61.0·52.8 − 27.3·30.4 = 2390.88
4→5: 27.3·36.1 − (−6.4)·52.8 = 1323.45
5→1: (−6.4)·0 − 0·36.1 = 0
Σ = 5383.93
```
Subtracting a round origin keeps the numbers small; the area does not change.

2
```
A = ½ × 5383.93
A = 2,691.965 m²
```

3 island (store) = 12.000 × 8.500
A-1 = 2,691.965 − 102.000
A-1 = 2,589.965 m² = 1.036 dunam
Pick inside takes the island away; the perimeter stays the outer one: 199.195 m.

Lot 2: chord area + arc segment (bulge 0.2, chord 30 m)

1 chords only: 30 × 20
600.000 m²

2 θ = 4 · atan(0.2)
θ = 0.789582 rad = 45.2397°

3 r = c / (2 sin(θ/2)) = 30 / (2 × 0.384615)
sagitta = bulge × c/2 = 0.2 × 15
r = 39.000 m · s = 3.000 m

4 segment = r²/2 · (θ − sin θ) = 760.500 × (0.789582 − 0.710059)
segment = 60.477 m²

5 A-2 = 600.000 + 60.477
P = 30 + 20 + r·θ + 20 = 70 + 30.794
A-2 = 660.477 m² · P = 100.794 m
The arc bows outward, so the segment is added.

4 What you should see

✓ **What you should see**

No.	From	m²	dunam	Perim. m
A-1	Click inside (1 island)	2,589.965	1.036	199.195
A-2	Polyline	660.477	0.264	100.794
A-3	Polyline (gap closed)	750.000	0.300	110.000
	Total	**4,000.442**	**1.600**	

The ☰ list shows the perimeter with 2 decimals, the table and Excel with 3.

5 Common mistakes

- Clicking inside the store: you get the store (102.000 m²), not the plot.
- A big gap (1 m or more) can join two areas into one. Keep it 0.05 – 0.10.
- Measuring lot 2 by its four corners only: 600.000 m², 60.477 m² short.

6 Check yourself

If the arc of lot 2 bowed inward (bulge −0.2), what would the area be?

Answer: 600.000 − 60.477 = 539.523 m²; the perimeter stays 100.794 m.

CAD & SURVEY
ENG. ALI

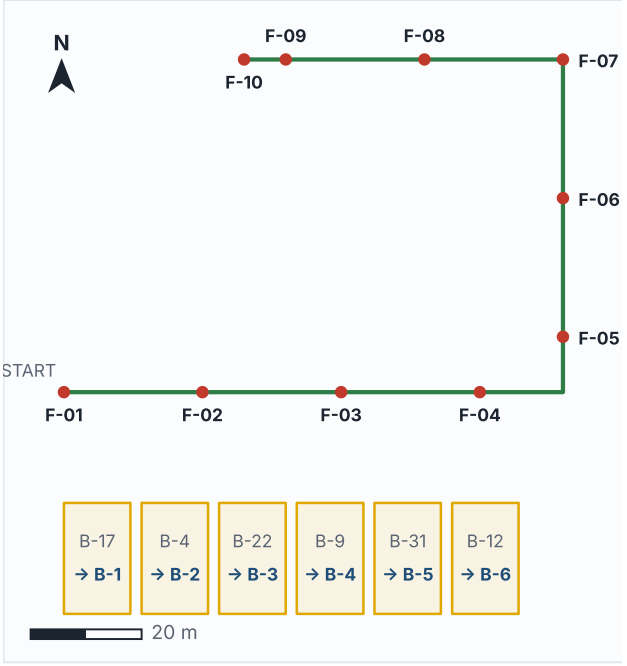
10 Auto Number ANUM

Number the posts of a new fence every 25 m, see how Count and Vertices differ, and put the plot numbers of block B in order.

1 Files in the folder

`ANUM_start.dxf`
the new fence (open polyline, 207.5 m) and block B with six old plot numbers

`ANUM_start.scr`
the same drawing as a script



The fence to scale with posts F-01 ... F-10, and block B renumbered.

2 Steps

1. Open `ANUM_start.dxf`, type **ANUM**. FORMAT: Type **1, 2, 3**, digits `2`, Start `1`, step `1`, Prefix `F-`.
2. Press **Divide**. DIVIDE: By **Distance** `25`, Text **Left side**, **Number start and end** ON. Click the fence near its START end.
3. **Undo**, then try By **Count** `10` and By **Vertices** on the same fence and count the numbers.
4. Block B: digits `1`, Start `1`, then **Renumber** with **Keep the words, change only the number** ON. Click the six plot texts from left to right, Enter.
5. **Excel** lists the numbers of the session.

💡 **Floating box:** While clicking (Click), press **N**: a small box opens next to the mouse to change the prefix, the next number and the suffix - Enter and go on. The gold 💡 line in the palette reminds you; **Turn off ×** in the box switches it off (the command line asks instead) and **Floating box** in the palette (or BOX) turns it back on.

🆕 **2.4.1 · Live:** with **Live** on (Text fold), changing the height, frame, angle or position with + / – redraws the numbers of the run at once — try it on the fence after step 2. A finished run keeps its text (prefix / digits); a number you erased stays erased.

3 Worked calculation by hand

Fence posts every 25 m (Number start and end ON)

1 `L = 90.0 + 60.0 + 57.5`

`L = 207.5 m`

Three straight segments of the polyline.

2 `s = 0, 25, 50 … 200 (floor(207.5 / 25) = 8 → 9 stations)`
`+ the end 207.5 (207.5 − 200 = 7.5 > 0)`

`10 numbers: F-01 … F-10`

The end is added because the last step is short.

3 `F-05: s = 100 → 100 − 90 = 10 m up the 2nd segment`
`F-08: s = 175 → 175 − 150 = 25 m along the 3rd (westward)`

`F-05 = E 724890.000 N 3385310.000 · F-08 = E 724865.000 N 3385360.000`

Position = start of the segment + the rest of the distance along it.

4 `Number start and end OFF → remove 0 and 207.5`
`By Count 10 → 11 numbers every 20.75 m`
`By Vertices → 4 numbers`

`8 · 11 · 4 numbers`

4 What you should see

✓ What you should see

No.	s (m)	E	N
F-01	0	724800.000	3385300.000
F-02	25	724825.000	3385300.000
F-03	50	724850.000	3385300.000
F-04	75	724875.000	3385300.000
F-05	100	724890.000	3385310.000
F-06	125	724890.000	3385335.000
F-07	150	724890.000	3385360.000
F-08	175	724865.000	3385360.000
F-09	200	724840.000	3385360.000
F-10	207.5	724832.500	3385360.000

Block B after Renumber — **`PLOT B-1 … PLOT B-6`**

Status line — **`10 numbers placed. Next: F-11`**

5 Common mistakes

- Clicking near the END of the fence: the numbering starts from the end (F-01 at 207.5).
- Digits still 2 in Renumber: "PLOT B-01" instead of "PLOT B-1".
- Renumber without "Keep the words": the text becomes only "F-1" (the full label).

6 Check yourself

With Distance 20 instead of 25 (ends on), how many numbers, and where is the last step?

Answer: 0, 20 … 200 = 11 stations, plus the end 207.5 = 12 numbers; the last step is 7.5 m.

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11 Volume Calc CVOL PRO

Prove CVOL on a pile whose volume is known by formula, get its weight and trucks, then design a platform on flat ground and check its fill by hand.

1 Files in the folder

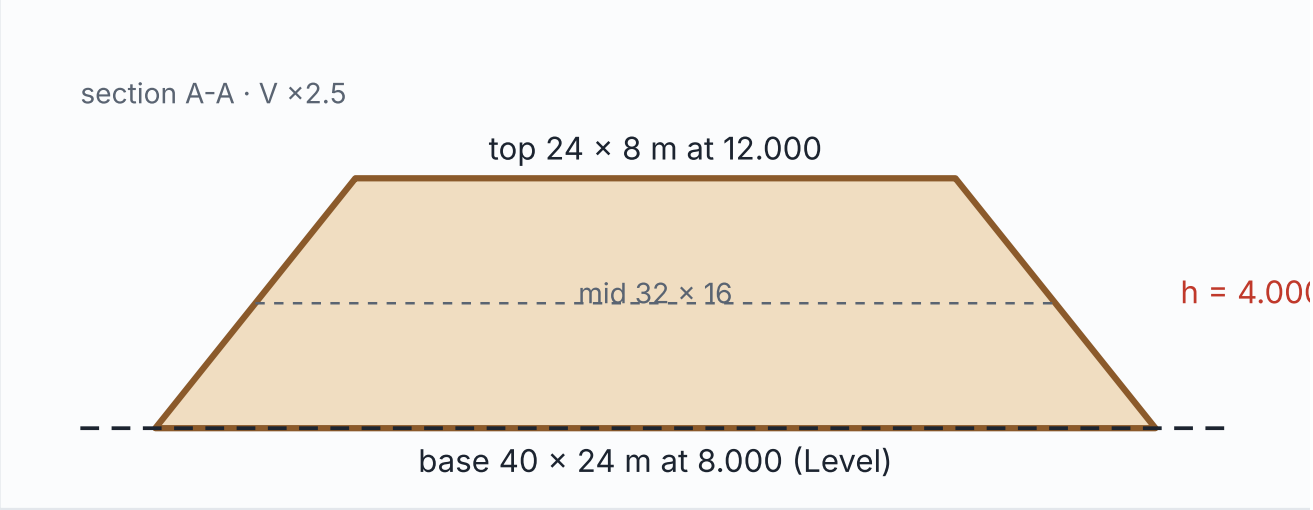
`CVOL_stockpile_start.dxf`
the 125 ST01 points (3D POINT)

`CVOL_Stockpile_ST01_frustum.csv`
the same points as a field file (PENZD)

`CVOL_grading_start.dxf`
platform edge (closed polyline) and ground points

`CVOL_Grading_NGL_flat_10m.csv`
flat ground 10.000 every 5 m

`CVOL_Grading_platform_outline.csv`
platform corners C1...C4



ST01 is a truncated pyramid: section A-A to scale (height ×2.5).

2 Steps

1. Open `CVOL_stockpile_start.dxf`, type **CVOL**, tab **Stockpile**. 1 · POINTS **File...** → `CVOL_Stockpile_ST01_frustum.csv`: the window says **Looks like PENZD**; codes EG 32 and TS 93; Outline from code = EG. Press **Add points**.
2. (Or **Select** the 125 points of the drawing with one window — same result.) Name `ST01`; Base **Level** `8.000`.
3. RESULT: Cut factor `1.25`, Density `1.6` t/m³, Truck `20` m³. **Calculate**, **Preview**, then **PDF** (one page).
4. Open `CVOL_grading_start.dxf`, tab **Grading**. 1 · GROUND **File...** → `CVOL_Grading_NGL_flat_10m.csv`. 2 · PLATFORM Edge **Pick polyline** (the yellow rectangle), Level `11.000`, Slope Flat, fill 1 : `2`, cut 1 : `1.5`. **Calculate**, **Preview**.

💡 **Floating box:** Grading, **+ Point**: after each click the design level is asked in a small box next to the mouse (Enter = the Level box). Set level uses the same box. The gold 💡 line in the palette reminds you; **Turn off** × in the box switches it off (the command line asks instead) and **Floating box** in the palette (or BOX) turns it back on.

3 Worked calculation by hand

Stockpile ST01: prismoid formula

1 `A1 = 40 × 24 = 960  A2 = 24 × 8 = 192  Am = 32 × 16 = 512`

base, top, middle

The middle section is the average of the sides: (40+24)/2 × (24+8)/2.

2 `V = h/6 × (A1 + 4·Am + A2) = 4/6 × (960 + 2048 + 192)`

V = 2,133.33 m³

CVOL (TIN of the 125 points) must give the same ±0.1 %.

3 `one triangle: V = A × (h1 + h2 + h3) / 3`

how the TIN adds it up

Each triangle is a prism with a sloped top; heights above the base level.

4 `Weight = 2133.33 × 1.6 ;  Trucks = ceil(2133.33 × 1.25 / 20) = ceil(133.3)`

Weight 3,413.3 t · Trucks 134

Weight from the volume; trucks from the factored volume (Cut factor 1.25).

Grading: platform 100 × 50 m at 11.000 on flat ground 10.000

1 `platform fill = 5000 m² × 1.00 m`

5,000.00 m³

2 `fill slope 1 : 2 → goes out 2.00 m; section = 1.00 × 2.00 / 2 = 1.00 m²`
`sides = 1.00 × perimeter 300 m`

300.00 m³

3 `4 corners = one cone: π × 2.00² × 1.00 / 3`

4.19 m³

At the corners the slope goes round.

4 `Fill = 5000.00 + 300.00 + 4.19`
`area with slopes = 104 × 54 − 4 × (4 − π)`

Fill = 5,304.19 m³ · 5612.57 m² (CVOL ≈ 5,613: it counts the slopes on a fine grid)

Daylight line 2.00 m out; balance level (shrink 1.00) = 10.000.

4 What you should see

✓ What you should see

Item	ST01	Grading
Points / area	125 · 960.00 m²	459 · 5,000.00 m²
V / Cut / Fill	V 2,133.33 · Cut 2,133.33 · Fill 0.00	Cut 0.00 · Fill 5,304.19
Other	Hmax 4.000 · 3,413.3 t · 134 trucks (×f)	with slopes ≈ 5,613 m² (exact 5,612.57) · daylight 2.00 m · balance 10.000

5 Common mistakes

- Base left on **Edge average** with a known datum: here it gives 8.000 too (all EG at 8.000), but on real piles agree the base first — every 10 cm counts.
- Codes switched off by mistake in the file window: the top points (TS) are left out and the volume is near zero.
- Grading ground survey that stops at the platform edge: the slopes cannot meet the ground (a warning is written). Survey a little wider.

6 Check yourself

ST01 with Base = Level 8.500 instead of 8.000: is the new volume about 960 × 0.5 less? Why not exactly?

Answer: About 449 m³ less, not 480: the sides slope in, so between 8.0 and 8.5 the pile is smaller than 960 m² (38 × 22 = 836 m² at 8.5). From 8.5 to 12: V = 3.5/6 × (836 + 4 × 31 × 15 + 192) = 1,684.67 m³.

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12 Profile Maker CPROF PRO

A road and a pipeline, from the files to the printed sheets: the route, the ground (one level typo to find), the design line with vertical curves, the crossings with their clearance, the remarks, the sheets for printing and the outputs - and every number checked by hand.

Road-1 (parts A, C, D) and the pipeline PL-10in (part B) live in the same drawing as two profiles. Do the parts in order: part C uses the crossings typed in part A. Your drawing changes as you go, so save the DWG after each part.

1 Files in the folder

`CPROF_start.dxf`
starting drawing: Road-1 centre line (CPROF-CL), the 10" pipeline route (PIPE-ROUTE), 6 objects crossing it on their own layers (EX-...), and 3 objects to project (TRAIN-PROJECT)

`CPROF_Road1_CL_STA_RL_DESC.csv`
Road-1 centre line: STA, RL, DESC, every 20 m, with one level typo at 0+660 and PIPE 8" at 0+340

`CPROF_Road1_LCLR_coords.csv`
the same road as 153 points E / N / Z with codes L / CL / R (±10 m)

`CPROF_Road1_design_PVI.csv`
the design: 4 grade points (PVI) with VC 120 and VC 160

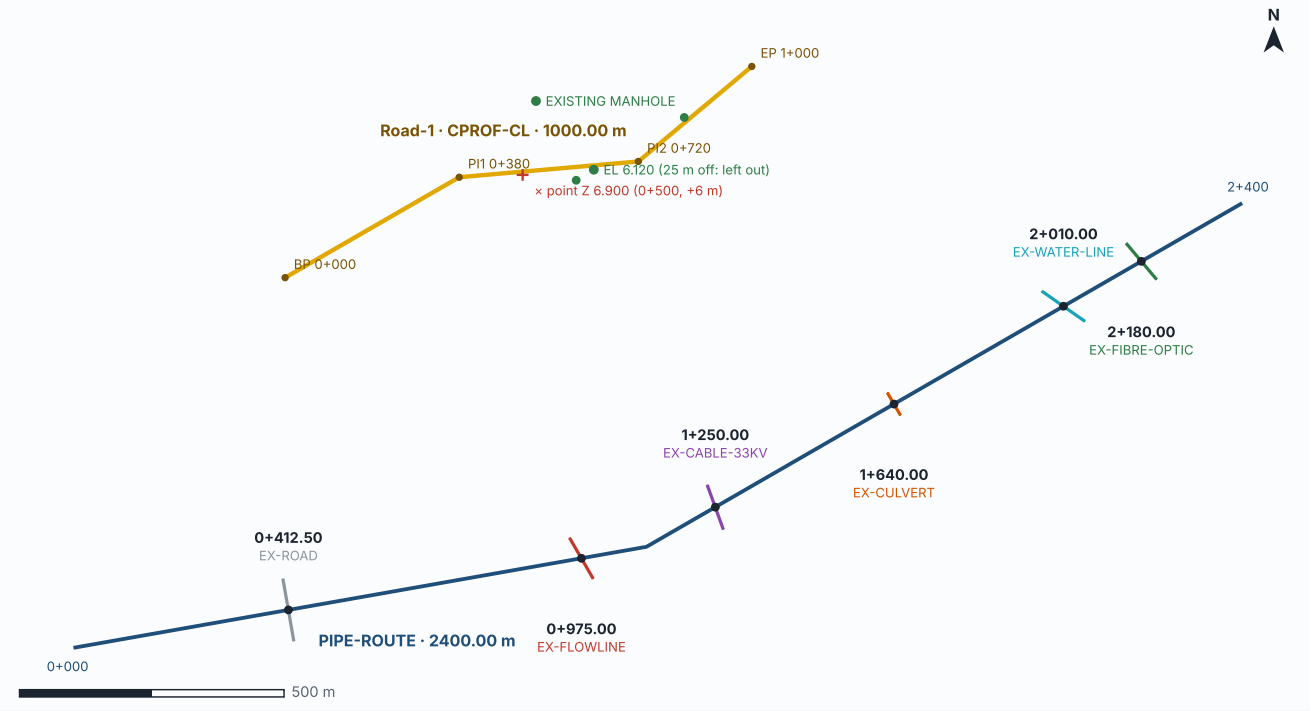
`CPROF_Pipe_route_NGL_TOP.csv`
the 10" pipeline: Station, NGL, TOP every 25 m (+ 0+412.50, 1+640.00), 2,400 m

`CPROF_Pipe_crossings.csv`
6 crossings: Station, Item, Level type (Top / Inv / Depth), Value, Diameter, Material

`CPROF_LongRoute_12km.csv`
a 12 km route, NGL every 10 m (1,201 rows) - for the sheets

`CPROF_Road1_CL_2digit_stations.csv`
Road-1 again with 2-digit stations 0+20 ... 10+00 - for the self-check

`CPROF_EXPECTED_answers.csv`
the answers: design levels, checks, clearances, sheets



CPROF_start.dxf to scale: Road-1 (gold, 3 legs, PIs at 0+380 and 0+720) and the pipeline route (blue, 2,400 m). The six objects crossing the pipeline are on their own layers; the dots near Road-1 are for "Project to profile".

2 Part A · Road-1: route and ground

1. Open `CPROF_start.dxf`, **SAVEAS** it as a DWG and type **CPROF**. At the top: Profile `Road-1`, Type **Road**.
2. **ROUTE** page: **Polyline** and click the yellow centre line (layer CPROF-CL). It shows **1000.00 m**, start: west end. Start station `0+000`, Interval **20**.
3. **GROUND** page, **CL only**, then **File...** → `CPROF_Road1_CL_STA_RL_DESC.csv`. The window says ✓ Detected: Station / Elevation / Description. Press **Import 51 points**.
4. It asks: *1 crossing(s) found in the descriptions: 0+340 PIPE 8"* - answer **Yes**. (The " in PIPE 8" is part of the text: the file has it as "PIPE 8""".)
5. POINTS · CL (NGL) · 51 pts · 1 to check: row 0+660.00 is red with 72.100. Fix it: **Manual**, click the red row (it comes into the boxes), Elev `7.210`, Enter.
6. **▶ Draw profile** and click an empty place right of the plan (the bottom-left corner). From now on the drawing is live.
7. **L · CL · R**, **File...** → `CPROF_Road1_LCLR_coords.csv` : Pt · E · N · Z · Code found, **Split into L / CL / R** ticked. **Import 153 points**; to *CL already has points* answer **Yes** (replace).

The level that jumps (0+660)

1. `neighbours: 0+640 = 7.216  0+680 = 7.223`
   `straight between them at 0+660 = (7.216 + 7.223) / 2`
   `7.2195`

2. `72.100 − 7.2195`
   `64.88 m → ⚠`
   More than max(2 m, 5 × the usual step) from both neighbours, and the neighbours agree: a missing decimal point (7.210).

✓ What you should see

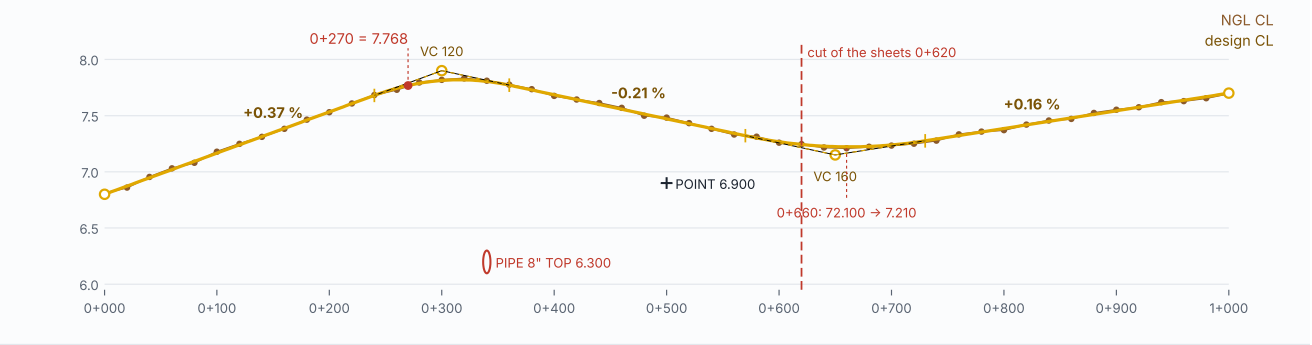
Where	Shows
ROUTE	`CPROF-CL · Polyline · 1000.00 m · start: west end`
warning line	`⚠ 0+660.00: 72.100 jumps 64.88 m from its neighbours — missing decimal point? Not drawn until fixed.`
after the fix	`51 pts, levels 6.809 (0+000) … 7.831 (0+320)`
CROSSINGS	`0+340.00 · Pipe · PIPE 8" · Ø 8" = 203.2 mm · no level (dashed line)`
LINES	`L 51 · CL (NGL) 51 · R 51 · 0+000 — 1+000 · CL solid, L dashed, R dotted`
L / R	`offset −10.00 / +10.00, level 0.250 under the CL (crossfall 2.5 %)`
at the bends	`R 0+382.22 · L 0+716.85 · (inside of the bend: the nearest point of the line)`

Why are two side points not at a round station? At a PI the file puts L and R on the bisector. The point on the inside of the bend is exactly 10.00 m from both legs and lands on a leg: R at PI1 → 0+382.22, L at PI2 →

0+716.85. The point on the outside is nearest to the PI itself: 0+380 at −10.24 m and 0+720 at +10.48 m. That is right - the tool projects each point onto the route.

3 Part A · The design line with vertical curves

1. **DESIGN** page: **Show design** ticked, **Grade points**, **File...** → `CPROF_Road1_design_PVI.csv` → **Import 4 PVIs**.
2. 2. ROAD WIDTH & CROSSFALL: Half width `10` L `10` R, Crossfall `-2.5` % L `-2.5` % R (the defaults). The L and R design is drawn by itself because the ground has L / R lines.
3. 3. CHECK: Max grade `6` % → read the result, Max cut and Max fill. Compare the profile with the figure below.



Road-1 to scale along (1 : 1000 here ≈ 0.85 px per m), levels ×100: the ground (brown, with the typo fixed) and the design (gold) with the crest VC 120 at 0+300 and the sag VC 160 at 0+650.

Grades and the level at 0+270 (inside the crest curve)

1. `g1 = (7.900 − 6.800) / 300 ; g2 = (7.150 − 7.900) / 350 ; g3 = (7.700 − 7.150) / 350`
   +0.367 % · -0.214 % · +0.157 %
   The table writes them with 2 decimals: +0.37 %, −0.21 %, +0.16 %.
2. `BVC = 300 − 120/2 = 0+240 ; EVC = 0+360`
   `z(BVC) = 7.900 − 0.003667 × 60`
   7.680
   0+270 is inside the curve.
3. `x = 270 − 240 = 30 ; tangent = 7.680 + 0.003667 × 30`
   7.790
4. `A = g2 − g1 = -0.5810 % ; y = A × x² / (200 × L) = -0.5810 × 900 / 24000`
   -0.0218
   L = 120 m. Negative A = a crest.
5. `z(0+270) = 7.790 − 0.022`
   = 7.768
6. `check at the PVI: e = A × L / 800 = -0.5810 × 120 / 800 ; 7.900 + e`
   -0.0871 → 7.813
   The middle-ordinate rule gives the band value at 0+300.

7 `edge L / R = CL + 10 × (−2.5 %) = 7.768 − 0.250`
`7.518`
The same 0.250 under the CL all along.

8 `cut / fill = design − ground: 0+800  7.386 − 7.371 ; 0+940  7.606 − 7.620`
`+0.015 fill · -0.014 cut`
The biggest ones. Written with 2 decimals: 0.01 and 0.01.

✓ What you should see

Station	0+000	0+100	0+240	0+270	0+300	0+360
Design CL	6.800	7.167	7.680	7.768	7.813	7.771

Station	0+460	0+570	0+650	0+730	0+800	1+000
Design CL	7.557	7.321	7.224	7.276	7.386	7.700

CHECK	Shows
Max grade	✓ 0.37 %
Max cut	0.01 m at 0+940.00
Max fill	0.01 m at 0+800.00
PVI table	0+000.00 6.800 +0.37 % · 0+300.00 7.900 −0.21 % 120 · 0+650.00 7.150 +0.16 % 160 · 1+000.00 7.700 end

4 Part A · A crossing, objects from the plan and remarks

1. **CROSSINGS** page, 2. CROSSINGS: click the row 0+340.00 PIPE 8". In 3. SELECTED: Ø `8"` (= 203.2 mm), Level **Top** `6.300`, Enter: the dashed line becomes an ellipse with Ø 8" · TOP 6.300.
2. **Drawing** → *Project points / blocks / texts to the profile…* and select the 3 green objects of layer TRAIN-PROJECT (a point, EXISTING MANHOLE, EL 6.120). To *1 object(s) have no level* press Enter (= remarks).
3. 4. REMARKS: Sta `0+000` Note `BEGIN ROAD-1` **Add**, then Sta `1+000` Note `END ROAD-1` **Add**. (The descriptions of the first file went away with it when you replaced the CL.)
4. **DESIGN** › 3. CHECK › Clearance `0.3` m: read the clearance lines.

Clearance on a road = design level − the crossing (road: no thickness)

1 `0+340 in the crest curve: x = 100 ; tangent = 7.680 + 0.003667 × 100 = 8.0467`
`y = -0.5810 × 100² / 24000 = -0.2421`
`design = 7.805`

2 `PIPE 8": top 6.300, bottom = 6.300 − 0.2032 ; gap = 7.805 − 6.300`
`1.505 below ✓`
The pipe is under the road: its top counts.

3 `0+500 on g2: 7.900 − 0.002143 × 200 = 7.4714 ; POINT 6.900`
`0.571 below ✓`
A projected point has no size.

✓ What you should see

Where	Shows
after Project	`⚠ 1 object(s) projected onto the profile · 1 remark(s) added · 1 left out (more than 15 m from the route).`
2. CROSSINGS · 2 items	`0+340.00 Pipe PIPE 8" TOP 6.300 · 0+500.00 Point POINT TOP 6.900 · offset +6.00`
4. REMARKS · 3	`0+000.00 BEGIN ROAD-1 · 0+840.00 EXISTING MANHOLE · 1+000.00 END ROAD-1`
CHECK › Clearance	`✓ 2 crossing(s) · least 0.571 m at 0+500.00 — 0+340.00 PIPE 8" · below · 1.505 m`

5 Part B · The 10" pipeline: ground, top of pipe, cover

1. Profile **+** (new profile), then the pencil (**Rename**) → `PL-10in`.
2. **ROUTE** › **Polyline**: click the blue route (layer PIPE-ROUTE): **2400.00 m**.
3. **GROUND** › **File...** → `CPROF_Pipe_route_NGL_TOP.csv` : ✓ Pipe column: TOP OF PIPE. **Import 99 points**. To *The file also has a TOP OF PIPE column (99 levels). Use it as the design line...?* answer **Yes**. The type turns to **Pipe** (auto ✓): interval 50, H 1:2000 / V 1:200.
4. **▶ Draw profile** and click a new place under the road profile.
5. **DESIGN** › 2. PIPE: Line is **Top of pipe**, Diameter `273.1` → it shows = 273.1 mm. Not 10: a 10" pipe is 273.1 mm outside, 10" = 254 mm is only its name.
6. 3. CHECK: Min cover `0.8` m (default) → read the result; look at the COVER band at 0+412.50 and 1+640.

Cover = NGL − top of pipe

1 `0+000.00: 6.000 − 4.800 ; 1+000.00: 5.896 − 4.696`
`1.200 · 1.200`
Normal cover.

2 `0+412.50 (road): 6.609 − 4.809`
`1.800`
Deeper from 0+400 to 0+425 under the road.

3 `1+640.00 (culvert): 4.386 − 2.286`
`2.100`
Deepest from 1+630 to 1+650 under the culvert.

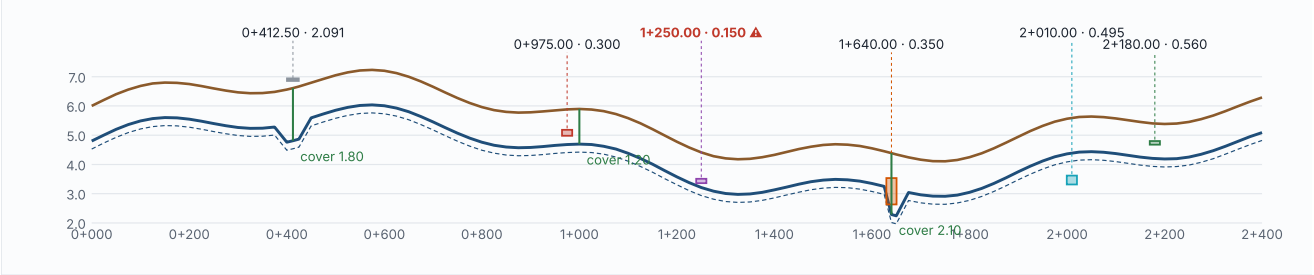
4 `bottom of pipe = top − 0.2731 ; 8" = 8 × 25.4 ; 12" = 12 × 25.4`
`203.2 mm · 304.8 mm`
A plain number up to 60 is read as inches, above as mm.

✓ What you should see

Where	Shows
Type	`Pipe · auto ✓ · interval 50 · H 1:2000 / V 1:200 · bands STATION · NGL · TOP OF PIPE · COVER`
DESIGN	`1. DESIGN LINE (TOP OF PIPE) · 99 rows · Diameter = 273.1 mm`
Min cover	`✓ 1.20 m (the normal cover, at one of its stations)`
COVER band	`1.20 · 1.80 (0+400 – 0+425) · 2.10 (1+630 – 1+650)`
steepest part	`-6.43 % (1+625 – 1+640) down to the culvert; a pipe has no grade limit`

6 Part B · Crossings: from the plan, from a file, and the clearance

1. **CROSSINGS** › **Drawing** → *Auto-detect on layers…*: click one line of each EX- layer (6 clicks), Enter. It marks them and asks *6 crossing(s) found on EX-ROAD, EX-FLOWLINE, … Add them to PL-10in?* → **Yes**.
2. Compare the 6 rows with the file: same stations 0+412.50 … 2+180.00, the kind from the layer name, but no level and no size (2D lines). Then **Clear** (it asks) → **Yes**.
3. **File…** → `CPROF_Pipe_crossings.csv` : Station · Item · Level type · Level · Diameter · Material found by themselves. **Import 6 crossings**.
4. **DESIGN** › 3. CHECK › Clearance `0.3` : read the summary and the six lines. The 1+250 row of the CROSSINGS table turns orange.



PL-10in to scale along, levels ×60: NGL, top of pipe (bottom dashed) and the six crossings with their clearance (red = under 0.30 m).

Clearance of a pipe: its top and its bottom (top − 0.2731) against the crossing's bottom and top

1. `1+250 POWER CABLE, Depth 0.900, Ø 150 mm: top = 4.411 − 0.900 = 3.511 ; bottom = 3.511 − 0.150`
   `3.361`
   Depth is measured from the NGL CL down to the top of the crossing.
2. `our top at 1+250 = 3.211 ; gap = 3.361 − 3.211`
   `0.150 above` ⚠
   Under 0.30 m.

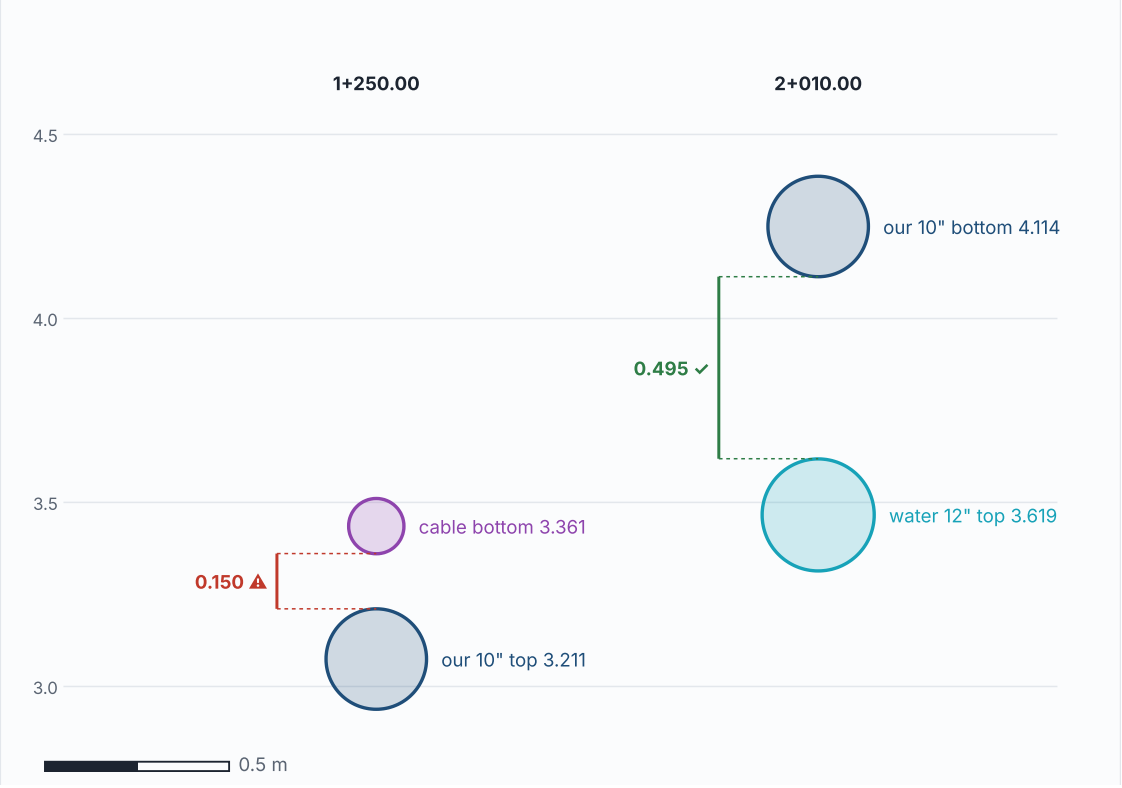
3 `2+010 WATER LINE, Inv 3.314, 12": top = 3.314 + 0.3048`
`3.619`
Inv is the bottom of the crossing.

4 `our top between 2+000 (4.363) and 2+025 (4.422): 4.363 + 0.059 × 10 / 25 = 4.3866`
`our bottom = 4.3866 − 0.2731`
`4.1135`
The TOP is read straight between the 25 m rows.

5 `gap = 4.1135 − 3.6188`
`0.495 below ✓`
The water line is under our pipe: our bottom counts.

6 `0+975 FLOWLINE, Top 5.185, 8": bottom = 5.185 − 0.2032 = 4.9818 ; gap = 4.9818 − 4.682`
`0.2998 → 0.300 ✓`
The tool compares to the millimetre: right on the limit = ✓.

Station	Crossing	Level	Ø	Top / bottom	Our top	CHECK
0+412.50	ROAD CROSSING (asphalt)	TOP 6.900	—	6.900	4.809	✓ above · 2.091 m
0+975.00	EXISTING FLOWLINE	TOP 5.185	8"	5.185 / 4.982	4.682	✓ above · 0.300 m
1+250.00	POWER CABLE 33kV	DEPTH 0.90	150 mm	3.511 / 3.361	3.211	⚠ above · 0.150 m
1+640.00	BOX / PIPE CULVERT	INV 2.636	900 mm	3.536 / 2.636	2.286	✓ above · 0.350 m
2+010.00	WATER LINE	INV 3.314	12"	3.619 / 3.314	4.387	✓ below · 0.495 m
2+180.00	FIBRE OPTIC	DEPTH 0.60	40 mm	4.801 / 4.761	4.201	✓ above · 0.560 m



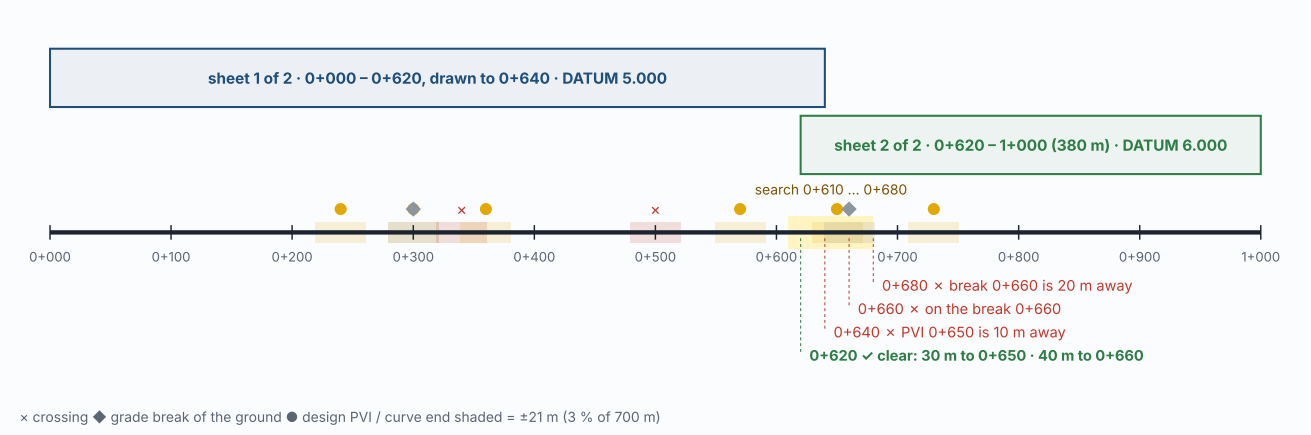
The two cases at true size (1 : 1): the cable 0.150 m above our pipe at 1+250 and the water line 0.495 m below it at 2+010.

✓ What you should see

Where	Shows
Auto-detect	`0+412.50 Road EX-ROAD · 0+975.00 Pipe EX-FLOWLINE · 1+250.00 Cable EX-CABLE-33KV · 1+640.00 Culvert EX-CULVERT · 2+010.00 Pipe EX-WATER-LINE · 2+180.00 Cable EX-FIBRE-OPTIC`
File...	`✓ 6 crossing(s) imported · Ø 8" = 203.2 mm · 150 mm · 900 mm · 12" = 304.8 mm · 40 mm`
CHECK › Clearance	`⚠ 1 of 6 under 0.30 m — ⚠ 1+250.00 POWER CABLE 33kV · above · 0.150 m`

7 Part C · Sheets for printing (Road-1, A1 at H 1:1000)

1. Profile → `Road-1`. **OUTPUT** › 3. RANGE AND SHEETS: tick **Split into sheets (print)**, Paper **A1** → it writes = 700 m a sheet at H 1:1000. Cuts **Auto**, Overlap `20` m, Place **Side by side**.
2. Read the sheets list, then tick **Overview** and Key plan **Plan**. Zoom to the match line at 0+620.
3. (Optional, the 12 km route) Profile **+**, rename `Long-12km`, **GROUND** › **File...** → `CPROF_LongRoute_12km.csv` (no route needed). Split into sheets, A1: count the sheets; Key plan **Profile** (no coordinates). Try H `2000` in 1. LOOK › Grid & scale, then put `1000` back - the look is kept per type, so Road-1 changes too.



Where the cut goes: the first cut wants 0+680; 0+680, 0+660 and 0+640 are too close to something, 0+620 is clear.

Sheet length, the cut and the datum of each sheet

1. `A1 frame ≈ 700 mm ; at 1:1000 1 mm = 1 m → 700 × 1000 / 1000`
   `700 m a sheet`
   At H 1:2000 the same paper takes 1,400 m.

2. `step = 700 − 20 (overlap) = 680 ; clear = max(5, 3 % × 700) = 21 m ; search 680 − 10 % × 700 = 610 … 680`
   `want 0+680`
   Only earlier, on the interval (20 m).

3 0+680: ground break 0+660 is 20 m away (< 21) ✗
0+660: on the break ✗ ; 0+640: PVI 0+650 is 10 m away ✗
0+620: 650 → 30, 660 → 40, 570 → 50 m
0+620 ✓
Obstacles: the crossings 0+340 and 0+500, the ground breaks 0+300 and 0+660, the PVIs and curve ends 0+240 0+300 0+360 0+570 0+650 0+730.

4 sheet 1 = 0+000 – 0+620, drawn to 0+620 + 20 = 0+640 ; what is left 1000 – 620 = 380 < 700
2 sheets

5 datum = floor(lowest – 0.25) ; sheet 1 lowest = PIPE 8" bottom 6.300 – 0.2032 = 6.0968
sheet 2 lowest = 6.960 (ground L / R at 0+660)
DATUM 5.000 · DATUM 6.000
Levels every 0.5 m: half a step under the lowest, rounded down to the metre. Without the PIPE 8" level sheet 1 would be 6.000.

✓ What you should see

Where	Shows
sheets list	1 of 2 · 0+000 · 0+620 · 620 m · 5.000 – 2 of 2 · 0+620 · 1+000 · 380 m · 6.000
title	Road-1 · Sheet 1 of 2 · 0+000 – 0+620 · H 1:1000 / V 1:100
match line	MATCH LINE 0+620 · see sheet 2 (red, layer CPROF-MATCH)
Long-12km	A1 · H 1:1000 → 18 sheets (cuts 0+680, 1+360, 2+000 …) · H 1:2000 → 10 sheets

8 Part D · Outputs: table, Excel, PDF report, DWG, Survey Report

1. Road-1, **OUTPUT** › 5. EXPORT › Stations **Every** `20` m. Then **Copy** at the bottom and paste into Excel; **Excel** writes the stations and a sheet Crossings; **Table** puts an AutoCAD table (click its corner).
2. **Project info…**: project, client, contractor, names and logos (once for all reports). Then **PDF** → Report options (preset Full, see the preview) → OK → save.
3. **Save as DWG…** → **Yes** = all the drawn profiles, **No** = this one. The DWG you work in does not change.
4. **Send to Survey Report**: SREPORT opens on the Roads tab with the rows added - design = Design level, NGL = Field level, Δ and Pass / Fail worked out.

Why Every 20 m and not Original? Original lists the measured stations to the millimetre: the two side points at the bends (0+382.22, 0+716.85) and the PVI 0+650 get their own rows, and an R point whose rounded coordinates put it 0.6 mm further along shows its 0+020.00 a second time. Every 20 m gives one clean row per station with L, CL and R side by side - what SREPORT › Roads wants.

✓ What you should see

Where	Shows
Copy	✓ Copied 51 station(s) (every 20 m) + 2 crossing(s) under them: paste into Excel.
columns	Station · E · N · NGL CL · NGL L · NGL R · Design CL · Design L · Design R · Cut/Fill · Grade % · Desc · Source
0+260 / 0+280	Design CL 7.744 / 7.788 (in the curve)
PDF · page 1	Length 1000.00 m · NGL highest 7.831 at 0+320 · lowest 6.809 at 0+000 · Design highest 7.819 at 0+315 · Max design grade ✓ +0.37 % (0+000 – 0+300) · limit 6 % · Max cut 0.01 m at 0+940 · Max fill 0.01 m at 0+800 · Crossings 2 · Clearance ✓ 2 checked, all ≥ 0.30 m · Sheets 2 (A1)
PDF · PL-10in	Length 2400.00 m · NGL highest 7.235 at 0+575 · lowest 4.110 at 1+750 · Top of pipe highest 6.035 at 0+575 · lowest 2.243 at 1+650 · Max design grade −6.43 % (1+625 – 1+640) · Min cover ✓ 1.20 m · min 0.8 m · Crossings 6 · Clearance ✗ 1 of 6 under 0.30 m
Send to Survey Report	✓ 51 row(s) of Road-1 sent to SREPORT › Roads (design = DESIGN, field = NGL, stations: every 20 m).

9 Common mistakes

- Deleting the red 0+660 row instead of fixing it: the reading at 0+660 is lost and the line runs straight from 0+640 to 0+680. Fix the level (Manual, click the row, 7.210).
- Typing the pipe diameter as 10: it is read as 10" = 254 mm, so the bottom of the pipe is 19 mm too high and the gap at 2+010 grows to 0.514 m. Type the real outside diameter 273.1.
- Answering No to the TOP column question: there is no design line, so no cover and no clearance. Import the file again and answer Yes.
- Importing the crossings file while the 6 auto-detected rows are still there: every crossing comes twice (the names differ). Clear first.
- Changing H 1:2000 for the long route and forgetting it: the scale is kept per type, so Road-1 changes to 1,400 m sheets (one sheet).
- Selecting more than the three TRAIN-PROJECT objects for Project: every other text within 15 m of the route becomes a remark.

10 Check yourself

1 · What is the design level at 0+700 (inside the sag curve at 0+650, VC 160)?

Answer: BVC 0+570 at 7.3214; x = 130; tangent = 7.3214 − 0.002143 × 130 = 7.0429; A = +0.157 − (−0.214) = +0.3714 %; y = 0.3714 × 130² / 32000 = 0.1962; level = **7.239**.

2 · Open `CPROF_Road1_CL_2digit_stations.csv` in a new profile. The tool asks how to read 0+20. Which answer gives the same road as file (a)?

Answer: No (1+00 = 100 m): 51 points 0 … 1,000 m, the same levels without the typo. With Yes (0+20 = 20 m) you get 0, 20 … 80 and then 1+00 = 1,000 m: a 920 m jump every 5 rows and a 10 km “road” - the window warns that the other reading may be right. The answer is remembered; change it with *Stations like 0+20* in the window.

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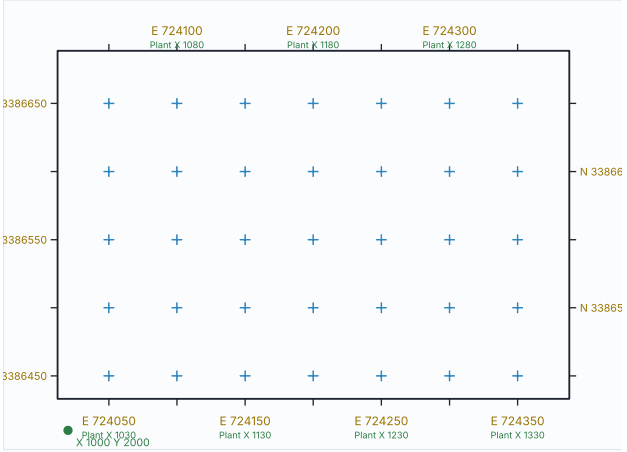
13 Coord Grid CGRID

Draw a 50 m coordinate grid on camp 4 with crosses, ticks and alternating labels, add the plant numbers under each label, and edit the grid live.

1 Files in the folder

`CGRID_start.dxf`
camp 4 boundary (closed polyline), buildings, plant origin point

`CGRID_start.scr`
the same drawing as a script



The expected grid to scale: crosses every 50 m, labels alternating, plant numbers in green.

2 Steps

1. Open `CGRID_start.dxf`, type **CGRID**. WHERE **Model**. SPACING ΔE `50` with **same** on. SHOW: **Crosses +** on, Lines off, **Frame ticks** on, **Frame** on.
2. Labels (Edit ▾): Height `4` m, decimals **0**, Prefix **E / N**, all four sides, **Alternate sides**.
3. Second system (Edit ▾): tick **Use a second coordinate system**, Method **One point (offset)**, Point 1 Drawing `724020` `3386410` (or **Pick** the PLANT ORIGIN point) → Second `1000` `2000`, Name `Plant`.
4. **Draw grid**. At *First corner of the grid area [Polyline]* type `P` and click the camp boundary.
5. Live edit: with Grid 1 active, change ΔE to `25`: the grid redraws in place (one U undoes it). Count again, then set it back to 50.

3 Worked calculation by hand

Which lines, which labels

1 `E: ceil(724012.4 / 50) = 14481 → 724050 ; floor(724387.9 / 50) = 14487 → 724350`
`7 lines E 724050 … 724350`
Only multiples of the spacing inside the area.

2 `N: ceil(3386433.2 / 50) = 67729 → 3386450 ; floor(3386688.6 / 50) = 67733 → 3386650`
`5 lines N 3386450 … 3386650`

3 `crosses = 7 × 5`
`35 crosses`
Every crossing is at least 16.8 m inside, more than half the cross (2.5 m).

4 alternate: k even → top / right, k odd → bottom / left
14481 odd → E 724050 at the bottom ; 67730 even → N 3386500 on the right
labels do not crowd

5 second system, one point: X = E − 724020 + 1000 ; Y = N − 3386410 + 2000
E 724050 → Plant X 1030 · N 3386450 → Plant Y 2040
Offset only: the second number goes under each label.

4 What you should see

✓ What you should see

Lines with ΔE = 50	**7 E · 5 N · 35 crosses**
Bottom labels	**E 724050 · E 724150 · E 724250 · E 724350**
Top labels	**E 724100 · E 724200 · E 724300**
Left / right labels	**N 3386450, 3386550, 3386650 / N 3386500, 3386600**
Second numbers	**Plant X 1030 … 1330 · Plant Y 2040 … 2240**
With ΔE = 25	**15 E · 10 N · 150 crosses**

5 Common mistakes

- Picking a window bigger than the boundary: the grid then runs outside the camp. Use the Polyline option.
- Text height 2.5 m on a 375 m site: labels too small to read when printed. For printing use **Layout viewport** (sizes in mm).
- Point + angle typed clockwise: in CGRID the angle is counter-clockwise (second from drawing).

6 Check yourself

With ΔE = 100, which E lines are drawn?

Answer: ceil(7240.124) = 7241 → 724100; floor(7243.879) = 7243 → 724300: three lines E 724100, 724200, 724300.

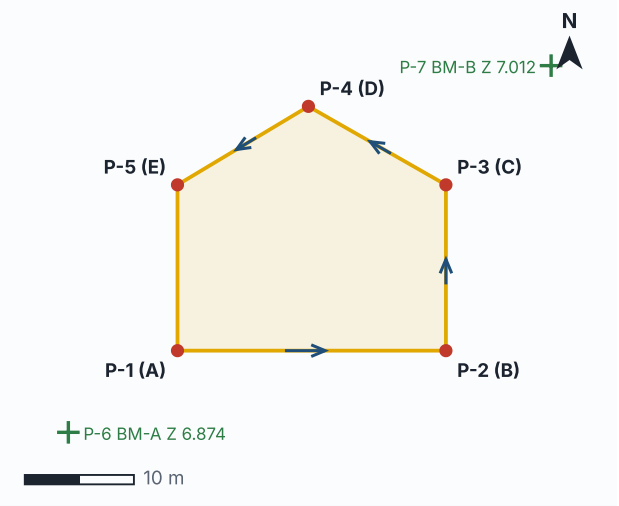
14 Point Table PTX

Number the corners of a new control room with one click, add two benchmarks, and write the points for the total station as CSV and Leica GSI-16 — knowing every character of the file.

1 Files in the folder

`PTX_start.dxf`
the control room outline A-B-C-D-E (closed polyline) and BM-A, BM-B with levels

`PTX_start.scr`
the same drawing as a script



The outline was drawn A → B → C → D → E (arrows): a click near A numbers it P-1 ... P-5 in that direction.

2 Steps

1. Open `PTX_start.dxf`, type **PTX**. 2. LABELS: Number **Text**, Show No ✓ E ✓ N ✓ (Z off), Place ↗, prefix `P-`, next `1` (↺ sets it to 1).
2. 1. POINTS: **Select objects**. Press **Start** and click the outline **near corner A**: "5 corner(s) numbered P-1 ... P-5".
3. Type `P` (pick) and click BM-A and BM-B (Node snap) → P-6, P-7. Enter. In POINTS AND COLUMNS turn on the Z column.
4. INSTRUMENT FILE: code `BLD`, order **P, E, N, Z**. Press **CSV**, then **Leica GSI** with **GSI-16**. Open both files in Notepad and compare with the box below.
5. Choose **GSI-8** and press **Leica GSI** again: the tool refuses and says to use GSI-16. Then **Clear** (it asks), turn on **⇄ Reverse polyline**, and select the outline near A again.

💡 **Floating box:** While picking, press **N**: a small box opens next to the mouse to change the prefix and the next number - Enter and go on. The gold 💡 line in the palette reminds you; **Turn off** ✕ in the box switches it off (the command line asks instead) and **Floating box** in the palette (or BOX) turns it back on.

3 Worked calculation by hand

Reading a GSI-16 line (P-6 = BM-A)

1 `*110006+0000000000000P-6 81..00+0000000724640000 82..00+0000003385812500 83..00+0000000000006874 71....+0000000000000BLD`

`one line = one point`

2 `*110006+0000000000000P-6`

word 11: block 0006 · id "P-6"

The id is filled with zeros on the left to 16 characters.

3
```
81..00+0000000724640000
82..00+0000003385812500
83..00+0000000000006874
```

E 724640.000 · N 3385812.500 · Z 6.874

Coordinates in mm: 724640.000 m × 1000 = 724640000 (9 digits).

4 `71....+0000000000000BLD`

code BLD

5 `GSI-8: 724640000 has 9 digits > 8`

GSI-8 is refused → use GSI-16

UTM coordinates never fit in GSI-8.

4 What you should see

✓ What you should see

```
Point,E,N,Z,Code
P-1,724650.000,3385820.000,0.000,BLD
P-2,724674.600,3385820.000,0.000,BLD
P-3,724674.600,3385835.200,0.000,BLD
P-4,724662.000,3385842.400,0.000,BLD
P-5,724650.000,3385835.200,0.000,BLD
P-6,724640.000,3385812.500,6.874,BLD
P-7,724684.250,3385846.125,7.012,BLD
```

```
*110001+0000000000000P-1 81..00+0000000724650000 82..00+0000003385820000 83..00+0000000000000000 71....+0000000000000BLD
*110002+0000000000000P-2 81..00+0000000724674600 82..00+0000003385820000 83..00+0000000000000000 71....+0000000000000BLD
*110006+0000000000000P-6 81..00+0000000724640000 82..00+0000003385812500 83..00+0000000000006874 71....+0000000000000BLD
*110007+0000000000000P-7 81..00+0000000724684250 82..00+0000003385846125 83..00+0000000000007012 71....+0000000000000BLD
```

Reverse polyline (from A) — **P-1 A · P-2 E · P-3 D · P-4 C · P-5 B**

5 Common mistakes

- Clicking the outline near corner C: the numbering then starts at C (P-1 = C).
- Selecting the outline twice: the corners are not added again (the status line says they were skipped).
- A point id with a space (P 1) or longer than 16 characters: GSI does not take it.

6 Check yourself

Write the GSI-16 E word for E = 724674.600.

Answer: 81..00+0000000724674600 (724674600 mm, filled with zeros to 16 digits).

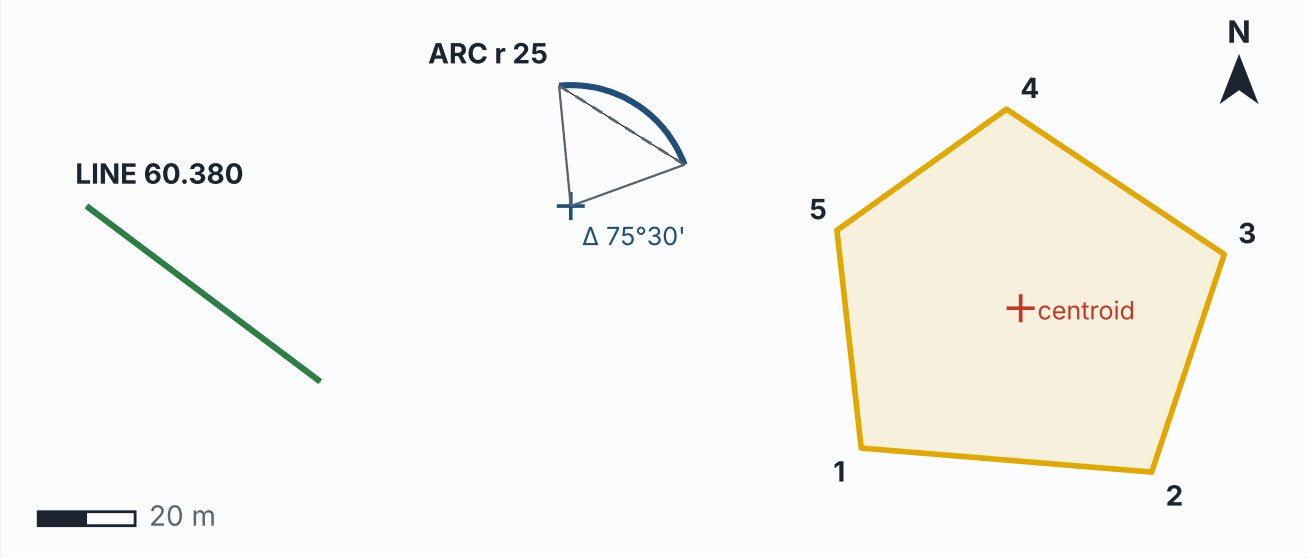
15 Object Info OINFO

Read a line, an arc and a closed polyline with OINFO, and work every card (length, bearing, arc, chord, area, perimeter, centroid) by hand.

1 Files in the folder

`OINFO_start.dxf`
one line, one arc and PLOT 5 (closed polyline on layer PLOTS)

`OINFO_start.scr`
the same drawing as a script



The three objects to scale; dashed = the chord of the arc; + = centroid of PLOT 5.

2 Steps

1. Open `OINFO_start.dxf`, type **OINFO** and click the line, then the arc, then the PLOTS polyline. Esc to stop (📌 keeps the palette).
2. In ⚙ change the bearing style to **Bearing N..E** and click the line again; then **Decimal deg**.
3. Click a card (e.g. AREA) to copy its value; press **Table** for the vertex table of the polyline, or **Excel**.

3 Worked calculation by hand

The line

1 ΔE = 724048.250 − 724000.000 = 48.250
ΔN = 3385963.700 − 3386000.000 = −36.300
dE 48.250 · dN −36.300

2 L = √(48.250² + 36.300²) = √(2328.0625 + 1317.6900)
LENGTH 60.380 m

3 Az = 180° − atan(48.250 / 36.300) = 180° − 53.0447°
BEARING 126°57'19" · S 53°02'41" E
ΔE + and ΔN − : south-east quarter.

The arc (centre 724100, 3386000, r 25, from 20° to 95°30')

1 Δ = 95.5° − 20° ; arc = r·Δ(rad) = 25 × 1.317724

DELTA 75°30'00" · ARC LENGTH 32.943 m

2 chord = 2·r·sin(Δ/2) = 50 × sin 37.75°

CHORD 30.611 m

3 start = (724100 + 25 cos 20°, 3386000 + 25 sin 20°)
end = (724100 + 25 cos 95.5°, 3386000 + 25 sin 95.5°)

E 724123.492 N 3386008.551 · E 724097.604 N 3386024.885

4 chord direction = (20 + 95.5)/2 + 90 = 147.75° (from east)
Az = 90° − 147.75° + 360°

CHORD BEARING 302°15'00"

Use the angles, not the rounded ends (they give 302°14'59").

The polyline (PLOT 5)

1 shoelace on local numbers (E − 724150, N − 3385940):
(10,10) (70,5) (85,50) (40,80) (5,55)

AREA 4,262.500 m² · 1.705 dunam · 0.4263 ha

2 perimeter = 60.208 + 47.434 + 54.083 + 43.012 + 45.277

PERIMETER 250.014 m

3 Cx = Σ(xi + xi+1)(xi·yi+1 − xi+1·yi) / (6A)
Cy = Σ(yi + yi+1)(xi·yi+1 − xi+1·yi) / (6A)

CENTROID E 724192.937 · N 3385978.861

Local 42.937, 38.861 + the origin.

4 What you should see

✓ What you should see

LINE	**LENGTH 60.380 · BEARING 126°57'19" · S 53°02'41" E · 126.9553°**
ARC	**ARC LENGTH 32.943 · CHORD 30.611 · 302°15'00" · DELTA 75°30'00"**
POLYLINE	**AREA 4,262.500 · PERIMETER 250.014 · CENTROID 724192.937, 3385978.861**

#	E	N	Length	Bearing	To
1	724160.000	3385950.000	60.208	094°45'49"	2
2	724220.000	3385945.000	47.434	018°26'06"	3
3	724235.000	3385990.000	54.083	303°41'24"	4
4	724190.000	3386020.000	43.012	234°27'44"	5
5	724155.000	3385995.000	45.277	173°39'35"	1

5 Common mistakes

- Reading the bearing in decimal degrees as D°M'S": 126.9553° is not 126°95'.
- Measuring the arc with the chord: 30.611 is the chord, the arc is 32.943.
- Drawing in mm: OINFO warns in orange only when the numbers look like millimetres, not because of INSUNITS.

6 Check yourself

What is the bearing of side 3 → 4 of PLOT 5 in the N..E style?

Answer: Azimuth 303°41'24" → N 56°18'36" W (360° − 303°41'24").

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16 Import Points CPOINTS

Import a day of field survey (30 points) with neat texts and one layer per code, see how bad rows and N-before-E files are handled, and check a distance by hand.

1 Files in the folder

`CPOINTS_start.dxf`
the survey area frame where the points must land

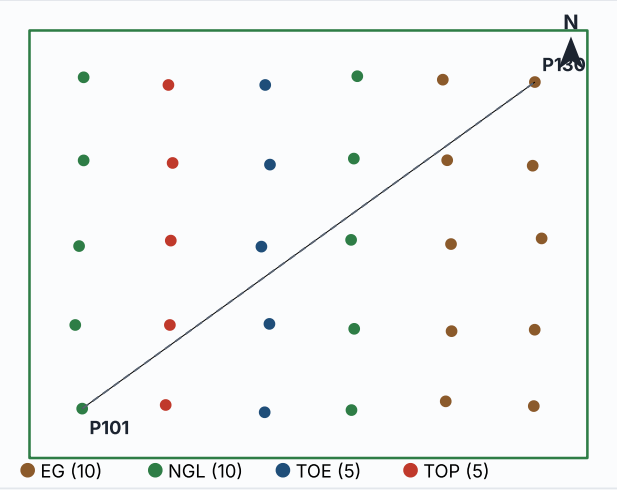
`CPOINTS_csv_header.csv`
30 points P101...P130 with a header

`CPOINTS_csv_bad_rows.csv`
the same with three bad rows

`CPOINTS_csv_N_before_E_noheader.csv`
no header, N before E

`CPOINTS_GSI16.gsi`
the same points as Leica GSI-16

`CPOINTS_xlsx_header.xlsx`
the same points in Excel



The 30 points to scale, coloured by code, inside the frame of the drawing.

2 Steps

1. Open `CPOINTS_start.dxf` and type **CPOINTS** (or **Import Points** on the ribbon).
2. 1 · FILE: **File...** → `CPOINTS_csv_header.csv`. Split by Auto (,), **First row is a header** ticked. 2 · COLUMNS: Point, E, N, Z and Code found.
3. 4 · DRAW: As AutoCAD points. Texts (Edit ▾): Point ✓, Z ✓ with Before `Z `, Code ✓, Height `0.5`, Place →. Point look ⊕ size `0.5`. Layer: **A layer per code** ✓. Press **Import 30 points**.
4. All points land inside the green frame. Change the text height to `0.8`: the texts of the last import update at once.
5. **Clear**, then **File...** → `CPOINTS_csv_bad_rows.csv`: read the three ⚠ rows in the Note column; Import (27 points). **Undo**.
6. **File...** → `CPOINTS_csv_N_before_E_noheader.csv` (no header, N first): the columns are swapped by themselves; the points land on the same places. Try `CPOINTS_GSI16.gsi` too.

3 Worked calculation by hand

How the columns are found, and a check by hand

1 `header: Point, E, N, Z, Code`
found by the names
E / X / EAST..., N / Y / NORTH..., Z / H / ELEV..., CODE.

2 `no header: P101, 3386499.787, 724100.418, 6.223, NGL`
`3386499.787 → 7 digits before the point = N ; 724100.418 → 6 digits = E`
`E column = C, N column = B (swapped by itself)`
In UTM 38N, E has 6 digits and N has 7.

3 `P101 → P130: ΔE = 724199.400 − 724100.418 = 98.982`
`ΔN = 3386571.220 − 3386499.787 = 71.433`
`d = 122.066 m · Az 054°10'58"`
Draw a LINE from P101 to P130 (Node snap) and check it with OINFO.

4 `bad rows: "7241x9.919" · "" · "n/a"`
`27 points · 3 rows skipped`
E not a number (P105), N empty (P112), Z not a number (P120).

4 What you should see

✓ What you should see

Preview line	**✓ 30 points**
P101 · P130	**724100.418, 3386499.787, Z 6.223 · 724199.400, 3386571.220**
Z	**6.223 … 8.771**
Layers	**CPOINTS-EG (10) · CPOINTS-NGL (10) · CPOINTS-TOE (5) · CPOINTS-TOP (5)**
Bad rows file	**27 points · P105 E is not a number · P112 N is empty · P120 Z is not a number**
N before E file	**E column = C, N column = B · same 30 points**
GSI16	**Detected "Leica GSI-16" · codes from word 71**

5 Common mistakes

- Untick "First row is a header" on a file with a header: the header row is shown ⚠ (E is not a number).
- Local small coordinates with N first: the digits cannot tell — press **Swap E/N** and check the preview.
- Decimal comma (724100,418) in a comma-separated file: the numbers break; save the file from Excel with semicolons.

6 Check yourself

You import the same file again. What does the tool ask, and what does Yes do?

Answer: It asks Replace or Add again: Yes = Replace (the last import is erased, then drawn again), No = Add again, Cancel = nothing.

17 Benchmark Manager CBM PRO

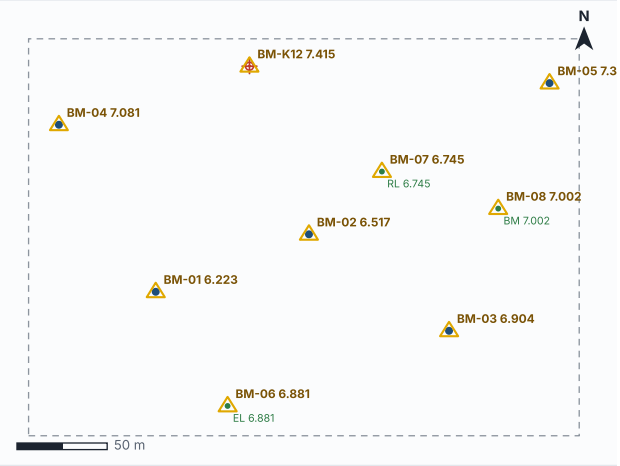
Register nine levelling marks of a plant as benchmarks — from points, level texts and a block with attributes — fill the missing levels, and check the latitude / longitude by hand.

1 Files in the folder

`CBM_start.dxf`
5 POINTs P1–P5 (P3, P5 with Z = 0), 3 texts T1–T3 and the block B1 (NAME / ELEV / DESC), UTM 38N

`CBM_start.scr`
the same drawing as a script (it also defines and inserts the block)

`CBM_EXPECTED_benchmarks.csv`
the answers: 9 benchmarks with E, N, level, description, latitude and longitude



The nine marks to scale: blue = POINT, green = TEXT, red = block; gold = the benchmark drawn by CBM with its name and level.

2 Steps

1. Open `CBM_start.dxf`, **SAVEAS** it as a DWG and type **CBM**: the palette opens.
2. 1. PROJECT: **+ New**, Name `WIP-2 Training`, **OK**. Check UTM zone `38` **N**.
3. 2. POINTS: **Pick** and click the point P1 (grey labels help). The small window shows Name BM-01, Type BM, Elevation 6.223 (taken from the object). Press **Save & draw**.
4. Go on without leaving Pick: P2, P3 (Elevation empty: type `6.904`), P4, P5 (type `7.350`).
5. Now the texts T1 "EL 6.881" and T2 "RL 6.745" (levels filled in), then T3 "BM 7.002": empty, type `7.002`.
6. Last the block B1: Name BM-K12, Elevation 7.415, Location / description GATE3-PLINTH from its attributes. **Save & draw**, then Esc to finish.
7. Click the row BM-01: the view zooms to it and 3. SELECTED shows its Geo line. Compare it with the calculation below. Then click BM-K12.
8. 4. DRAW › Symbol & label **Edit ▾**: choose **◂ Control point**, then style **Print Mono** — all 9 symbols are redrawn at once. **U** (AutoCAD U) brings the old look back.
9. Outputs: **Excel** (with latitude / longitude), **KML** for Google Earth and **PDF** (page 1 overview + one card per benchmark).

3 Worked calculation by hand

Where each value comes from

1 `POINT: E, N = its position; Z ≠ 0 → elevation`
`BM-01 6.223 · BM-03 empty`
P3 and P5 have Z = 0: the window opens with Elevation empty, you type 6.904 and 7.350.

2 TEXT: E, N = insertion point; the text read as a level only as a number or with EL / ELEV / LEVEL / LVL / RL / Z / FGL / NGL / TOC / IL

"EL 6.881" → 6.881 · "RL 6.745" → 6.745 · "BM 7.002" → empty

"BM" is a name, not a level word, so T3 gives no level: type 7.002.

3 BLOCK: E, N = insertion point; attributes NAME → name, ELEV → level, DESC → description

BM-K12 · 7.415 · GATE3-PLINTH

The block brings its own name; the others take the next free number BM-01 ... BM-08.

UTM → latitude / longitude of BM-01 by hand (summary of what Geo.cs does)

1 k0 · A = 0.9996 × 6,367,449.146 (A = rectifying radius of WGS 84)

k0·A = 6,364,902.166 m

A comes from the ellipsoid only (a = 6378137, f = 1/298.257223563); zone 38: central meridian 38 × 6 − 183 = 45°.

2 ξ = N / (k0·A) = 3386499.787 / 6,364,902.166
η = (E − 500000) / (k0·A) = 224100.418 / 6,364,902.166

ξ = 0.532058420 · η = 0.035208777

Northing and false-easting offset turned into angles (radians).

3 ξ' = ξ − Σ βj sin(2jξ) cosh(2jη)
η' = η − Σ βj cos(2jξ) sinh(2jη)   (j = 1…4, β1 = 0.000837732)

ξ' = 0.531324072 · η' = 0.035180130

The Krüger series: four small terms.

4 χ = atan(sin ξ' / √(sinh²η' + cos²ξ'))
Δλ = atan(sinh η' / cos ξ')

χ = 30.4218026° · Δλ = 2.3371814°

χ is the conformal latitude; Δλ the difference from 45°.

5 φ from χ (Newton, 2–3 turns)
λ = 45° + Δλ

φ = 30.590071370° · λ = 47.337181404°

φ − χ = 0.1683° here.

6 degrees → D°M'S" (× 60, × 60)

30°35'24.257"N · 47°20'13.853"E

This is the Geo line of 3. SELECTED.

A quick check without the series

1 ν = a / √(1 − e² sin²φ)
Δλ ≈ (E − 500000) / (k0 · ν · cos φ) = 224100.418 / (0.9996 × 6,383,672.936 × 0.860830)

Δλ ≈ 2.3375° (exact 2.3372°)

Good to about 0.01°: enough to catch a wrong zone (a zone is 6° wide) or E / N swapped.

4 What you should see

✓ What you should see

Name	Type	E	N	Elev	✓	From
BM-01	BM	724100.418	3386499.787	6.223	✓	POINT P1
BM-02	BM	724185.262	3386531.640	6.517	✓	POINT P2
BM-03	BM	724262.905	3386478.118	6.904	✓	POINT P3 · typed
BM-04	BM	724046.776	3386592.305	7.081	✓	POINT P4
BM-05	BM	724318.560	3386615.442	7.350	✓	POINT P5 · typed
BM-06	BM	724140.250	3386436.510	6.881	✓	TEXT "EL 6.881"
BM-07	BM	724225.700	3386566.380	6.745	✓	TEXT "RL 6.745"
BM-08	BM	724290.115	3386545.870	7.002	✓	TEXT "BM 7.002" · typed
BM-K12	BM	724152.330	3386624.775	7.415	✓	BLOCK CBM_TEST_TAG

SELECTED · BM-01	**Geo 30°35'24.257"N · 47°20'13.853"E**
SELECTED · BM-K12	**Geo 30°35'28.279"N · 47°20'15.898"E**
Status line	**✓ BM-K12 added and drawn.**
Drawing	**9 blocks on layer CBM, on top of the objects (nothing erased)**

5 Common mistakes

- Making no project first: Pick says "⚠ Choose or make a project first."
- Expecting a level from "BM 7.002": the word BM is not a level word. Write levels as 7.002, EL 7.002 or RL 7.002.
- Using Select (window) with the grey labels on: P1 … B1 are texts and become benchmarks too. Freeze layer CBM-TEST-LABELS first.
- A wrong UTM zone: the latitude / longitude jump by degrees (zone 39 puts BM-01 near 41°E). E / N stay right; only Geo, PDF and KML are wrong.

6 Check yourself

You pick one more text, "Z=6.512", after the nine. What name and level does the window show?

Answer: Name BM-09 (the next number after BM-08; BM-K12 is not a number) and Elevation 6.512 (Z= is a level word).

18 Length Calc CLEN PRO

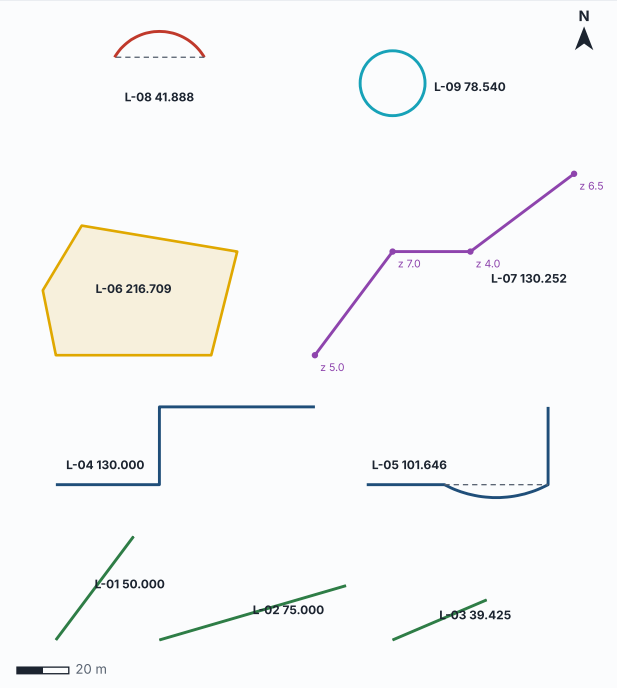
Measure nine objects of every kind — lines, polylines with an arc, a closed plot, a 3D trench, an arc and a tank — get the summary by type, and prove the tricky lengths by hand.

1 Files in the folder

`CLEN_start.dxf`
L-01 … L-09: 3 lines, 2 polylines (L-05 with an arc), the plot L-06, the 3D trench L-07, an arc and a circle

`CLEN_start.scr`
the same drawing as a script

`CLEN_EXPECTED_lengths.csv`
the answers: every length, the sums by type with the share and the total



The nine objects to scale with their lengths; dashed = chords (not counted); z = levels of the 3D trench.

2 Steps

1. Open `CLEN_start.dxf`, SAVEAS it as a DWG and type CLEN: the small bar appears.
2. ⚙ › Decimals 3 (the default is 2), unit m ▾.
3. Pick and click L-01 … L-09 in the order of the grey numbers. Every click adds a row; Σ on the bar grows to 863.459 m.
4. Open ☰ List (9): BY TYPE on top. Click Polyline: ITEMS shows L-04 and L-05 (Polyline · arcs) and both are highlighted.
5. 2 points and click the two ends of L-01 (Endpoint snap): L-10 "2 points" 50.000 is added. ↶ takes it back.
6. Click m ▾ and choose ft: Σ shows 2,832.872 ft; back to m. Then Table (click the top-left corner of the table), Excel and PDF.

3 Worked calculation by hand

L-05: polyline with an arc segment

1 `724120,3386060 → 724150,3386060`
`30.000 m`
An ordinary straight side.

2 chord c = 724190 − 724150 = 40.000 · bulge = 0.25
θ = 4 · atan(0.25)
θ = 0.979915 rad = 56.1450°
The bulge is tan(θ/4); AutoCAD keeps it on the vertex.

3 r = c ÷ (2 · sin(θ/2)) = 40 ÷ (2 × 0.470588)
sagitta = bulge × c/2 = 0.25 × 20
r = 42.500 m · s = 5.000 m

4 arc = r · θ = 42.500 × 0.979915
arc = 41.646 m
Not the chord (40.000).

5 724190,3386060 → 724190,3386090
L-05 = 30.000 + 41.646 + 30.000
L-05 = 101.646 m
ITEMS shows Polyline · arcs; with the chord it would be 100.000.

L-07: 3D polyline (trench with levels)

1 $L = \sqrt{(\Delta E^2 + \Delta N^2 + \Delta Z^2)}$
1→2: $\sqrt{(30^2 + 40^2 + 2^2)} = \sqrt{2504}$
2→3: $\sqrt{(30^2 + 0^2 + 3^2)} = \sqrt{909}$
3→4: $\sqrt{(40^2 + 30^2 + 2.5^2)} = \sqrt{2506.25}$
50.0400 + 30.1496 + 50.0625
Each side with its level difference.

2 L-07 = 50.0400 + 30.1496 + 50.0625
L-07 = 130.252 m (2D 130.000)
The level differences add 0.252 m: this is the true length on the ground.

L-06: closed polyline → perimeter

1 1→2: $\sqrt{(60^2 + 0^2)} = 60.000$
2→3: $\sqrt{(10^2 + 40^2)} = 41.231$
3→4: $\sqrt{(60^2 + 10^2)} = 60.828$
4→5: $\sqrt{(15^2 + 25^2)} = 29.155$
5→1: $\sqrt{(5^2 + 25^2)} = 25.495$
P = 216.709 m
Side 5→1 is the closing side: it counts.

L-08 arc and L-09 circle, then the total

1 arc: r = 20, 30° → 150°: θ = 120° = 2.094395 rad
r · θ = 20 × 2.094395
L-08 = 41.888 m (chord 34.641)

2 circle: 2 · π · 12.5
L-09 = 78.540 m
The circumference only.

3 Σ = 50.000 + 75.000 + 39.425 + 130.000 + 101.646 + 216.709 + 130.252 + 41.888 + 78.540

Σ = 863.459 m = 2,832.87 ft

ft = m ÷ 0.3048. Share = type length ÷ total × 100.

4 What you should see

✓ **What you should see**

Type	Count	Length m	Share
Line	3	164.425	19.0 %
Polyline	2	231.646	26.8 %
Closed polyline	1	216.709	25.1 %
3D polyline	1	130.252	15.1 %
Arc	1	41.888	4.9 %
Circle	1	78.540	9.1 %
TOTAL	**9**	**863.459**	**100 %**

No.	Type	Layer	Length m
L-01	Line	CLEN-LINES	50.000
L-02	Line	CLEN-LINES	75.000
L-03	Line	CLEN-LINES	39.425
L-04	Polyline	CLEN-PLINES	130.000
L-05	Polyline · arcs	CLEN-PLINES	101.646
L-06	Closed polyline	CLEN-PLOT	216.709
L-07	3D polyline	CLEN-3D	130.252
L-08	Arc	CLEN-ARC	41.888
L-09	Circle	CLEN-CIRCLE	78.540

With the default 2 decimals: Σ 863.46 m; L-05 101.65, L-07 130.25.

5 Common mistakes

- Measuring an arc by its chord: L-05 would be 100.000 instead of 101.646, L-08 34.641 instead of 41.888.
- Taking the plan length of the 3D trench (LIST / DIST in plan): 130.000 instead of 130.252.
- Clicking L-06 twice: the same object is never added twice, the count stays 9.
- Clear with labels in the drawing: Yes also erases the labels and the numbering starts again from L-01.

6 Check yourself

What share of the total do the arc and the circle make together, and what does Σ show in km?

Answer: (41.888 + 78.540) ÷ 863.459 × 100 = 13.9 %; Σ = 0.863 km (km shows at least 3 decimals).

19 Survey Select CSEL PRO

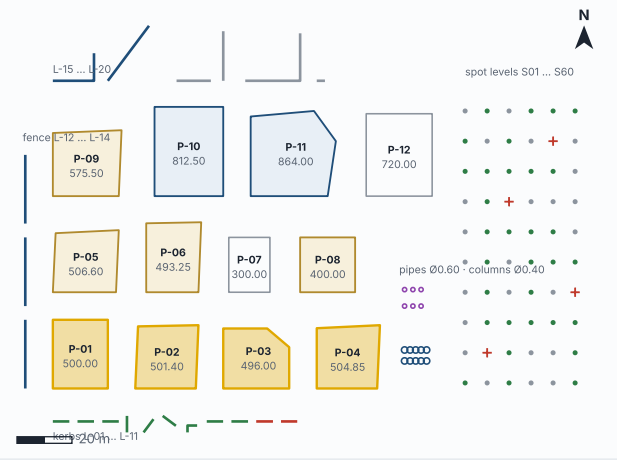
Find objects by their value in a busy site drawing: plots of about 500 m², a range and a side, 6 m kerbs, Ø 0.60 pipes, spot levels in a band and the ones shot without a level — then Focus and a PDF report.

1 Files in the folder

`CSEL_start.dxf`
12 plots P-01 … P-12, 20 lines L-01 … L-20, 10 pipes Ø 0.60 + 6 columns Ø 0.40, 60 spot levels S01 … S60 (4 with Z = 0), 10 level texts

`CSEL_start.scr`
the same drawing as a script

`CSEL_EXPECTED_counts.csv`
the answers: every step with its window and count, then every plot, line and spot level with its value



The site to scale: gold = about 500 m² (found by "500"), sand = also in 400-600, blue = over 800; green lines = 6 ± 0.05, red = near misses; green dots = levels 7.00-8.50, red crosses = Z = 0.

2 Steps

1. Open `CSEL_start.dxf`, **SAVEAS** it as a DWG and type **CSEL**: the palette scans the drawing by itself — status `Scanned Model: 158 objects.`. The tiles show `Lines 21 · Closed 30 · Circles 16 · Points 60 · Texts 47 · Blocks 0`.
2. WHAT: click **Closed**, then **Lines** to switch Lines off (one kind always stays on). In CLOSED · AREA type `500` and leave **± tolerance** empty (= 1 %): the grey line says `495.00 – 505.00 m²` and RESULT `4 of 30`. P-01 … P-04 glow gold.
3. Type `400-600` instead: the box splits into From `400` / To `600`, `400.00 – 600.00 m²` → `8 of 30` (P-01 … P-06, P-08, P-09).
4. Type `>800`: `≥ 800.00 m²` → `3 of 30` — P-10, P-11 and the drawing frame (a closed polyline too). Open **More** and type Layer `PLOTS` (or ▾ and click it): `2 of 30`.
5. **Focus**: every other object is hidden, only P-10 and P-11 show. **Focus** again = all back. Then empty the Layer box.
6. Only **Lines** on. LINES · LENGTH `6`, ± tolerance `0.05`: `5.95 – 6.05 m` → `9 of 21` (L-01 … L-09). Click a row of the list: zoom + bright mark for 3 s.
7. Only **Circles** on, the chip on **Ø**. Value `0.6`, ± `0.005`: `0.595 – 0.605 m` → `10 of 16` — the ten pipes.
8. Only **Points** on. POINTS · LEVEL `7.00-8.50` → `7.000 – 8.500 m` → `32 of 60`. Then `0` (tolerance empty) → `4 of 60`: the points without a level (S08, S24, S39, S53).
9. Back to **Closed**: `400-600` with Layer `PLOTS` (`8 of 30`), then **PDF**: summary, distribution chart, plot plan (found plots gold and numbered, the rest faint) and the list.

3 Worked calculation by hand

P-02 and P-05 by the shoelace formula (coordinates from the first corner)

1 P-02 (E, N − 724030, 3386000): 0,0 · 22,0 · 23,23 · 1,22.6

1→2: 0 × 0 − 22 × 0 = 0

2→3: 22 × 23 − 23 × 0 = 506

3→4: 23 × 22.6 − 1 × 23 = 496.8

4→1: 1 × 0 − 0 × 22.6 = 0

Σ = 1002.8 → A = 1002.8 ÷ 2 = 501.40 m²

Taking the first corner away changes no area and keeps the numbers small (the scan does the same with the full UTM values).

2 P-05 (E, N − 724000, 3386035): 0,0 · 23,0 · 24,22.6 · 1,21.5

1→2: 0 × 0 − 23 × 0 = 0

2→3: 23 × 22.6 − 24 × 0 = 519.8

3→4: 24 × 21.5 − 1 × 22.6 = 493.4

4→1: 1 × 0 − 0 × 21.5 = 0

Σ = 1013.2 → A = 506.60 m²

Term = x(this corner) × y(next) − x(next) × y(this). Half the sum is the area.

3 500 ± 1 % = 500 ± 5.00

495.00 – 505.00 m²

P-02 501.40 is inside; P-05 506.60 is 1.60 m² (1.32 %) over the top: left out. P-06 493.25 is under 495.00.

The other windows

1 6 ± 0.05

5.95 – 6.05 m

L-08 5.96 and L-09 6.04 count; L-10 6.07 and L-11 5.93 do not.

2 L-05: √(3.6² + 4.8²) = √36

L-07: 2.50 + 3.50

6.00 m · 6.00 m

A slanted line and a polyline of two sides: the whole length is judged.

3 Ø = 2 × R

Ø 0.6 ± 0.005

0.595 – 0.605 m

Pipes R 0.30 → Ø 0.600: in. Columns R 0.20 → Ø 0.400: out.

4 400-600 · >800 · 7.00-8.50

400.00 – 600.00 · ≥ 800.00 · 7.000 – 8.500

A range and a side need no tolerance. The ends count: P-08 = 400.00 is found, and so are the spot levels 7.000 and 8.500.

5 Σ (8 plots) ÷ 8

Σ = 3,977.60 m² · 497.20 m²

The PDF summary: total, then the average. Min 400.00, max 575.50.

Where the "of" numbers come from

1 Closed = 12 plots + frame + north arrow + 16 circles
30
A circle is a closed shape too (by its area).

2 Lines = 20 lines / polylines + the title-block line
21

3 Texts = 12 plot names + 20 line names + 10 level texts + 5 title texts
47

4 Points with Z = 0
S08 · S24 · S39 · S53
A spot level shot without a level. "0" with an empty tolerance = exactly 0.000.

4 What you should see

✓ **What you should see**

Step	Tile	Value	Layer	RESULT
2	Closed	500		4 of 30
3	Closed	400-600		8 of 30
4	Closed	>800		3 of 30
4	Closed	>800	PLOTS	2 of 30
6	Lines	6 ± 0.05		9 of 21
7	Circles Ø	0.6 ± 0.005		10 of 16
8	Points	7.00-8.50		32 of 60
8	Points	0		4 of 60
9	Closed	400-600	PLOTS	8 of 30

Tiles	**Lines 21 · Closed 30 · Circles 16 · Points 60 · Texts 47 · Blocks 0**
PDF · summary	**count 8 · total 3,977.60 m² · min 400.00 · max 575.50 · average 497.20**
Drawing	**nothing changes: the gold glow and Focus are only on the screen**

5 Common mistakes

- ">800" gives 3, not 2: the drawing frame is a closed polyline of 51,110.37 m². Use More › Layer (or Window) to keep to the plots.
- Typing 0.3 for the pipes while the chip says Ø: nothing is found (0.3 is the radius). Type 0.6, or click the chip to R and type 0.3.
- Leaving Layer PLOTS in More: the lines, circles and points then give "Nothing found" — they are on other layers.
- Expecting the closed count of the tile to be 12: circles, the frame and the north arrow are closed shapes too (30).

6 Check yourself

Try yourself: Lines only, type 25 with the tolerance empty. How many, and which? Then Texts only (Number): >8 — how many level texts?

Answer: 5 of 21: L-12 … L-16 (24.75 – 25.25 m; L-15 is a polyline 15 + 10, L-16 a 15-20-25 slant). Texts: 5 of 47 — +8.10 · RL 8.75 · 8.32 · TOC 9.05 · NGL 8.20.

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20 Object Notes CNOTE PRO

Leave four site notes in a drawing — on a footing with a photo, on an area, on a polygon and a voice note — set reminders, see the red alert of a late note when the drawing opens, then pins and the PDF.

1 Files in the folder

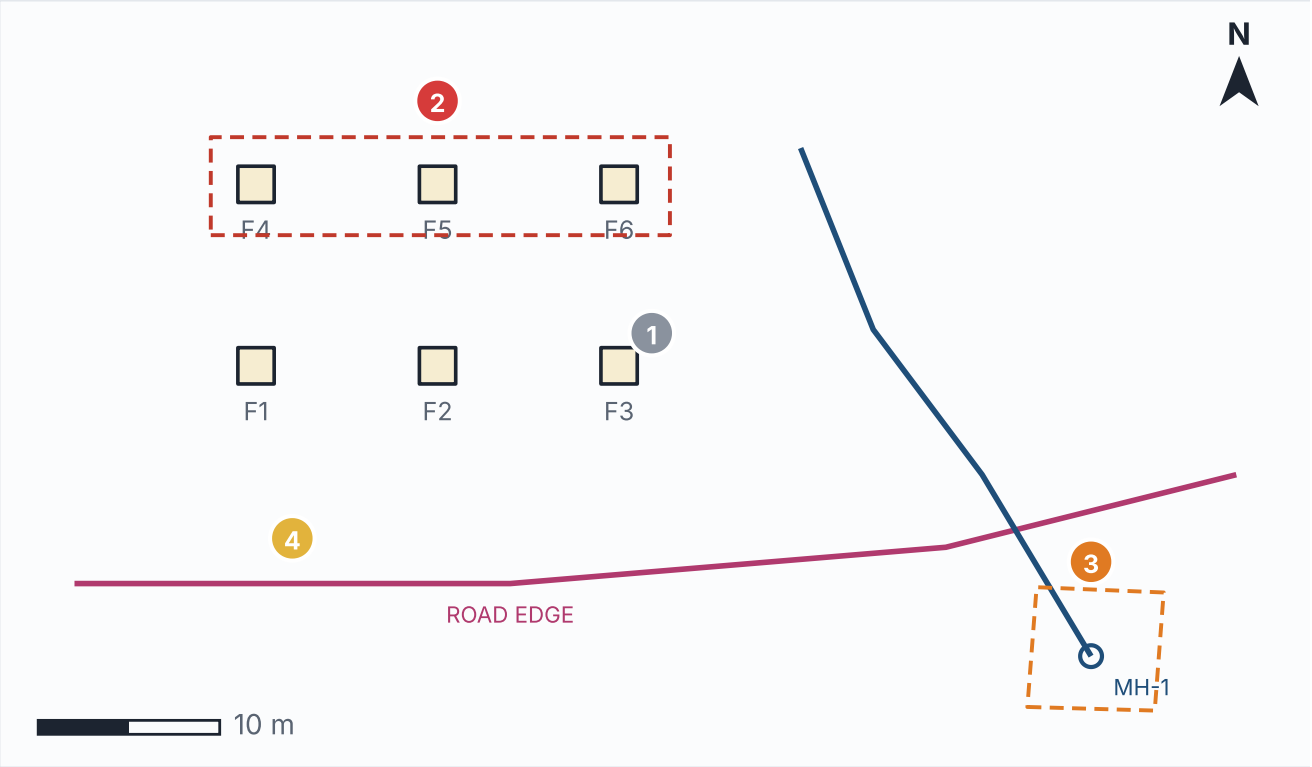
`CNOTE_start.dxf`
Block B: footings F1 – F6 (2.0 × 2.0 m), the road edge, the drain line and the manhole MH-1

`CNOTE_start.scr`
the same drawing as a script

`CNOTE_photo_F3_rebar.jpg`
sample photo (drawn) of the F3 rebar, 35 KB

`CNOTE_photo_drain_MH1.jpg`
sample photo (drawn) of the drain at MH-1, 25 KB

`CNOTE_EXPECTED_notes.csv`
the answers: the four notes, their state and colour, the list order, the alert and the PDF tiles



The site with the four pins after step 6. Dashed = the window of #2 and the polygon of #3 (kept in the notes, not drawn in the DWG).

2 Steps

1. Open `CNOTE_start.dxf`, **SAVEAS** it as a DWG and type **CNOTE**: the palette says "No notes yet - press New note, Area or Polygon".
2. **New note** and click the outline of footing F3. TITLE `F3 rebar check`, TEXT `16 mm @ 200, cover 75 mm OK`. ATTACH › **Photo** → `CNOTE_photo_F3_rebar.jpg` (its thumbnail shows). REMIND ME › **+1 week**. **Save**: pin #1 (gold) at F3.
3. **Area** and drag a window round F4 – F6. TITLE `Pour next week`. REMIND ME: **Today**, then click the day in the date box and press ↓ once (yesterday). **Save**: pin #2 is red and pulses, the list shows "1

day late" on top. Nothing is drawn in the DWG.

4. **Polygon**: click 4 corners round MH-1 (about 6 × 6 m), Enter. TITLE `Drain outlet level check`, ATTACH › **Photo** → `CNOTE_photo_drain_MH1.jpg`, REMIND ME › **+1 day**, **Save**: pin #3 orange, "due tomorrow".
5. **New note** and click the road edge. TITLE `Road edge kerb`. ATTACH › **Voice**: say for about 10 s "check the kerb line against the design levels", then **Stop**. The red tile "voice 0:10" plays when clicked. REMIND ME › **None**, **Save**: pin #4 gold.
6. Click note #1 in the list (zoom, F3 blinks gold 3 times), then **✓ Done**: its pin turns grey. The chips read `All 4 · Open 3 · Late 1 · Done 1`.
7. **QSAVE**, close the drawing and open it again: the alert comes up by itself (see below). **Show it** → the palette opens on Late with #2 chosen and blinking.
8. **Pins on** → **Pins off**: the pins, callouts and the pulse go; click again for **Pins on**. Then **PDF**.

💡 **Floating box:** Quick notes: press New note and type **Q**; every click opens a small box next to the mouse (title + one line), Enter saves it and the next click is the next note. Enter without a click finishes. The gold 💡 line in the palette reminds you; **Turn off ×** in the box switches it off (the command line asks instead) and **Floating box** in the palette (or BOX) turns it back on.

3 Worked calculation by hand

The colour of a note: days left = reminder date − today

1. `#2 reminder = yesterday`
   `−1 → LATE · red #D63B3A`
   Below 0 = late: the pin pulses, the list says "1 day late".
2. `#3 reminder = +1 day`
   `+1 → Due soon · orange #E07A22`
   0 = "due TODAY", 1 or 2 days = due soon: both orange.
3. `#4 no reminder · #1 +1 week`
   `– / +7 → Open · gold #E2B33C`
   More than 2 days or no date: gold, no alert.
4. `#1 after ✓ Done`
   `Done · grey #8A929E`
   Never in an alert again (Open again brings it back).
5. `The alert on opening: notes not done with days left ≤ 2`
   `#2 (−1) · #3 (+1)`
   One is late → the red level; its title counts the late ones only: "1 note is LATE!".

What the attachments cost inside the DWG

1. `photos (kept as they are, each ≤ 2 MB)`
   `CNOTE_photo_F3_rebar.jpg 35 KB · CNOTE_photo_drain_MH1.jpg 25 KB`
   35,978 and 25,741 bytes.

2 `16 kHz × 16 bit × 1 = 32,000 B/s`
`10 s × 32,000 + 44`
`320,044 B = 313 KB`
A WAV voice note of 10 seconds (44 = the WAV header).

3 `2 MB = 2,097,152 B ÷ 32,000`
`≈ 65.5 s`
Longer than that is turned to 8 kHz (16,000 B/s): 2:00 = 1,920,044 B, still under 2 MB.

4 `50 MB ÷ 35 KB`
`≈ 1,457`
Photos like these that one drawing can hold (the limit of all embedded items).

4 What you should see

✓ What you should see

No	Title	Link	Reminder	List line	Pin
#2	Pour next week	Area	yesterday	1 day late	● red, pulses
#3	Drain outlet level check	Polygon	+1 day	due tomorrow	● orange
#4	Road edge kerb	Object	None	no reminder · voice 0:10	● gold
#1	F3 rebar check	Object	+1 week	done (date)	● grey

Alert · English	**1 note is LATE! · Don't forget it · #2 "1 day late" · #3 "tomorrow" · Show it · Remind in 1 h**
Alert · Iraqi	**عندك ملاحظة فات موعدها! · لا تنساها · متأخرة يوم · باچر · شوفني ياها · ذكرني بعد ساعة**
Alert · MSA	**لديك ملاحظة تجاوزت موعدها! · لا تنسَها · متأخرة يومًا · غدًا · اعرضها · ذكّرني بعد ساعة**
Alert look	**red band, pulsing red border, ringing bell, blinking badge; no plain close button**
PDF	**NOTES 4 · OPEN 3 · LATE 1 · DONE 1 · the table, then each note with its text and photos; #4 "voice note 0:10"**

The alert speaks the messages language of My Profile (Auto: by country, Iraqi when not set). The list is sorted: late, due soon, open, done.

5 Common mistakes

- Clicking the text "F3" instead of the footing outline: the note is linked to the text, and the pin follows the text when it moves.
- Waiting for the alert right after Save: it comes when the drawing is opened (and again one hour after "Remind in 1 h").
- Looking for the window or the polygon in the drawing: they are kept in the note only. Click the note: the area blinks gold.

- Expecting pins on paper: pins are only on the screen, they never plot. Use the PDF report.

6 Check yourself

Try yourself: tomorrow you open the drawing again without changing anything. What does the alert say about #2 and #3?

Answer: Still "1 note is LATE!" (only #2 is late), now with the badge "2 days late"; #3 is due today: orange badge "due TODAY". Mark #2 done and the next opening shows the orange level "1 note is due TODAY".

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21 My Profile `CSPROFILE`

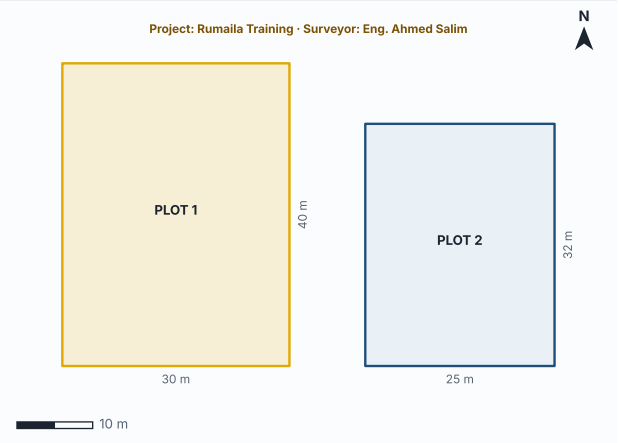
Fill your profile once — name, country, two instruments and a project — link a drawing at its first save, and watch a report fill itself and a calibration alert come up.

1 Files in the folder

`PROFILE_start.dxf`
PLOT 1 (30 × 40 m) and PLOT 2 (25 × 32 m) for a quick CAREA report

`PROFILE_start.scr`
the same drawing as a script

`PROFILE_EXPECTED_fields.csv`
the answers: what My Profile, the first-save card, the report fields and the calibration alert show



The two plots of the report; the project and the surveyor come from My Profile.

2 Steps

1. Ribbon CAD & SURVEY › **My Profile** (or type **CSPROFILE**). Tab **Me**: Name (English) `Eng. Ahmed Salim`, Name (Arabic) `م. أحمد سالم`, Role **Surveyor**, Company `Basra Survey Co.`, Country **Iraq · العراق ▾**, Messages language **Auto (by country)**. Use your own name if you like — the answers below use this one.
2. Tab **Instruments** › **+ Instrument**: **Total station**, Make / model `Leica TS07`, Serial No. `1234567`, Last calibration `01-03-2025` → Next due fills `01-03-2026`, the pill turns red "late … d".
3. **+ Instrument** again: **GPS**, `Trimble R10`, `5512A01`, Last calibration = the first day of the month two months ago (for example `01-08-2026`) → green "valid".
4. Tab **Projects** › **+**: name `Rumaila Training`, Client `Training Client Co.`, Location `South Rumaila, Basra`. INSTRUMENTS FOR THIS PROJECT: tick both. ASK ABOUT THE PROJECT: **At the first save** (the default). **Save**.
5. Open `PROFILE_start.dxf` and **SAVEAS** it as a DWG. After the save a small card slides in at the bottom-right: "This drawing is for which project?" with **Rumaila Training ▾** preselected. Click **Link**.
6. Type **CAREA**, **Select** PLOT 1 and PLOT 2, Enter. Right-click **PDF** = Report options: Project **Rumaila Training ▾**; **Project info…** shows Project, Location, Owner / client and Surveyor already filled. Make the PDF.
7. Close AutoCAD, start it again and open the drawing: about 10 s later the calibration alert (see below). **I renewed it** opens My Profile on the Leica: type today as Last calibration → green "valid", **Save**.

3 Worked calculation by hand

Calibration dates and the alert

1 Next due = last calibration + 1 year

01-03-2025 → 01-03-2026 · 01-08-2026 → 01-08-2027

Leave Next due empty: it follows the calibration date by itself.

2 days left = next due − today (example today = 25-10-2026)

Leica -238 · Trimble +280

Leica: pill "late 238 d", alert badge "238 days late". Trimble: "valid", no alert.

3 the levels

< 0 red · ≤ 7 orange · ≤ 30 gold · > 30 valid

Red = band, pulsing border and swinging icon; orange = swinging icon; gold = calm. The list pill turns orange "soon" from 30 days.

Names in the card and in the messages

1 "Eng. Ahmed Salim" – "Eng."

A + S = AS

The initials in the round avatar (when there is no photo).

2 Arabic name "م" – "م. أحمد سالم." → first word

أحمد · Ahmed

Arabic messages use the Arabic first name; English ones (and the reports) the English name.

3 Country Iraq + Messages language Auto

iq → "عاشت إيدك يا أحمد، التقرير جاهز"

Egypt would give "تسلم إيدك يا أحمد ...", English "Well done Ahmed, the report is ready".

The CAREA report of the two plots

1 30 × 40 · 2 × (30 + 40)

1,200.000 m² · 140.000 m

2 25 × 32 · 2 × (25 + 32)

800.000 m² · 114.000 m

3 Σ ÷ 2500

2,000.000 m² = 0.800 dunam

1 dunam = 2,500 m².

4 What you should see

✓ What you should see

Card header	AS · Eng. Ahmed Salim · Surveyor · Basra Survey Co.
Preview	"عاشت إيدك يا أحمد، التقرير جاهز"
Instruments	Leica TS07 · S/N 1234567 — late … d (red) · Trimble R10 · S/N 5512A01 — valid (green)
First save	This drawing is for which project? · Rumaila Training ▾ · Link · Not now · Not for this drawing · Don't ask me anymore (when Messages language = English; Iraqi by default: هذا الرسم لأي مشروع؟ · اربط · مو هسه)
Command line	My Profile: this drawing is linked to the project "Rumaila Training".
Project info…	Project Rumaila Training · Location South Rumaila, Basra · Owner / client Training Client Co. · Surveyor Eng. Ahmed Salim
CAREA PDF	A-1 1,200.000 m² · A-2 800.000 m² · total 2,000.000 m² = 0.800 dunam
After the PDF	a short "well done" card with your name (the words change)
Calibration alert	يا أحمد، معايرة جهازك خلصت! · جدّدها قبل الشغل الجاي — English: Ahmed, your instrument's calibration has ended! · Renew it before the next job
Alert buttons	جدّدت المعايرة · ذكرني باچر · ذكرني بعد أسبوع · لا تذكرني بهذا الجهاز — I renewed it · Remind me tomorrow · In a week · Don't remind me for it

Everything stays on this PC (registry + %AppData%\CADSURVEY\profile.dat); the drawing keeps only its project name.

5 Common mistakes

- Arabic letters in Name (English), Company or the project name: a warning shows — the PDF reports print Latin letters only.
- A Project info box you typed before in CAREA stays as it is: only empty boxes are filled. Empty it to get the profile value.
- Waiting for the calibration alert right after Save: it comes when AutoCAD starts (and once a day).
- "Don't ask me anymore" on the card: no more questions on save (the setting becomes When I make a report). Change it back in Projects › ASK ABOUT THE PROJECT.

6 Check yourself

Try yourself: set the Leica's Next due to a date 5 days from today and start AutoCAD again. Which level, title and badge?

Answer: Orange (≤ 7 days): "Ahmed, a calibration ends this week" · "Book the calibration", badge "in 5 days" (Iraqi "باقي 5 أيام" · "يا أحمد، معايرة جهازك قربت تخلص"). A new due date also clears a mute or a snooze.

22 Coord System + Dual Draw `CSCOORD · CSDRAW` PRO

One drawing in UTM 38N with a plant (main system) and two sites, each with its own local system: set them once, check that every tool follows the right system, then draw with local numbers using Dual Draw and Pick site.

1 Files in the folder

`CSCOORD_System_Plant.ctrans`
the drawing's main system: PLANT ↔ UTM 38N, a point + rotation 12.5° CW

`CSCOORD_System_SiteA_PS3.ctrans`
Site A's system: PS3 ↔ UTM 38N, one point (shift only)

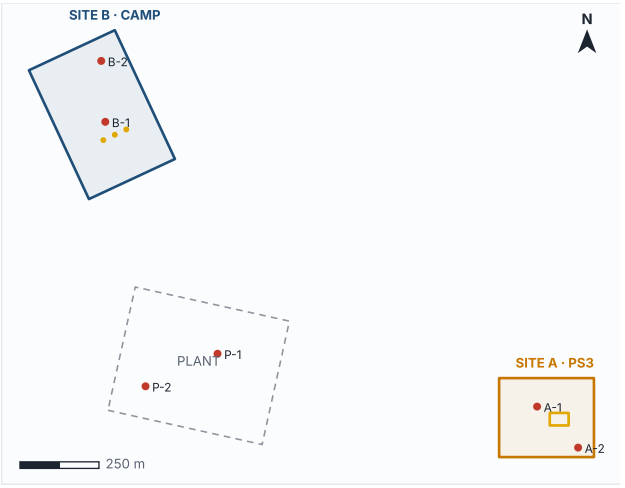
`CSCOORD_System_SiteB_Camp.ctrans`
Site B's system: CAMP ↔ UTM 38N, two points (the rotation is worked out)

`CSCOORD_start.dxf`
the starting drawing in UTM 38N: plant fence, the boundaries of Site A and Site B, six check points (no systems yet)

`CSCOORD_start.scr`
the same drawing as an AutoCAD script (SCRIPT command) - only if the DXF does not open

`CSCOORD_ready.dxf`
the same drawing with the three systems and both sites already saved inside it: open it and draw at once

`CSCOORD_EXPECTED_points.csv`
the answers: every point in its local system and in UTM 38N



To scale: grey = the plant fence (main system PLANT), orange = Site A (PS3), blue = Site B (CAMP, turned 25°); red = check points; gold = what you draw.

2 Steps

1. Part 1 · Setup. Open `CSCOORD_start.dxf` and **SAVEAS** it as a DWG. Type **CTRANS**, **File...** and open the three files `CSCOORD_System_Plant.ctrans`, `CSCOORD_System_SiteA_PS3.ctrans`, `CSCOORD_System_SiteB_Camp.ctrans` one by one: they join your projects list.
2. Type **CSCOORD**. Main system: choose `WIP-2 Plant (training)` from the list and press **Use for this drawing**.
3. SITES: **+ Site**, name `SITE A`, click the orange boundary. Then **+ Site**, name `SITE B`, click the blue boundary. Both show "⚠ no system yet".
4. Select SITE A › **System...** › `PS-3 Pump Station (training)`. Select SITE B › **System...** › `Camp C-1 (training)`. Close the window: the setup is saved inside the drawing.
5. Short way: open `CSCOORD_ready.dxf` instead — the systems and sites are already in it.
6. Part 2 · Check. **CLABEL** (or Quick Coord) on P-1, A-1 and B-1: each label writes the second system of the place it is in — PLANT, PS3 or CAMP. Compare with the table below.

7. Part 3 · Draw. Type **CSDRAW**. Press **Pick site** and click anywhere inside Site A: the list shows SITE A, its boundary flashes and the rows read PS3 X / Y and UTM E / N.
8. Start **PLINE**. In the PS3 row type the pump foundation: `560,500`, `620,500`, `620,540`, `560,540` (X Enter Y Enter each), then `C` and Enter to close it.
9. **Pick site** inside Site B. With no command running, type the tents T-1 `120,150`, T-2 `160,150`, T-3 `200,150` in the CAMP row: three POINTs. **Recent** ▾ lists them in both systems.
10. Part 4 · Safety. Pick Site A again and type PS3 `300,300`: it is outside Site A → an orange line and card, the number is selected. Type over it, or Enter again to put it in anyway.
11. Choose the drawing's system (PLANT) in the list and type PLANT `2175.791`, `1055.811`: it is the corner PF-1 inside Site A → it goes in at once, with an **i** note only.

3 Worked calculation by hand

Site A: one point = a shift only

1. `E = 722600.000 + (X − 500.000) · N = 3388300.000 + (Y − 500.000)`
   A-1: E 722620.000 · N 3388360.000
   A-1 is X 520.000 Y 560.000 in PS3: (520 − 500) = 20 m east and (560 − 500) = 60 m north of the link point.

The plant (main system): a point + rotation 12.5° CW

1. `dX = 1100.000 − 1000.000 · dY = 1050.000 − 1000.000`
   dX = 100.000 · dY = 50.000
2. `E = 721500.000 + dX·cos12.5° + dY·sin12.5°`
   `N = 3388500.000 + dY·cos12.5° − dX·sin12.5°`
   P-1: E 721608.452 · N 3388527.171
   cos 12.5° = 0.976296 · sin 12.5° = 0.216440

Site B: two points, the tool finds the rotation

1. `direction 1 → 2 in CAMP and in UTM`
   90.0000° · 114.9999°
   CAMP: straight north (X stays 100).
2. `90.0000° − 114.9999°`
   -25.000° → 25.000° CCW
   Negative = counter-clockwise. The View card of the site shows the same rotation.
3. `B-1: X 150.000 Y 200.000 → E, N`
   E 721253.054 · N 3389261.762

4 What you should see

✓ **What you should see**

Point	Site	System	X	Y	E	N
P-1	-	PLANT	1100.000	1050.000	721608.452	3388527.171
P-2	-	PLANT	900.000	900.000	721380.726	3388424.014
A-1	SITE A	PS3	520.000	560.000	722620.000	3388360.000
A-2	SITE A	PS3	650.000	430.000	722750.000	3388230.000
B-1	SITE B	CAMP	150.000	200.000	721253.054	3389261.762
B-2	SITE B	CAMP	220.000	380.000	721240.424	3389454.480
PF-1	SITE A	PS3	560.000	500.000	722660.000	3388300.000
PF-2	SITE A	PS3	620.000	500.000	722720.000	3388300.000
PF-3	SITE A	PS3	620.000	540.000	722720.000	3388340.000
PF-4	SITE A	PS3	560.000	540.000	722660.000	3388340.000
T-1	SITE B	CAMP	120.000	150.000	721246.995	3389203.768
T-2	SITE B	CAMP	160.000	150.000	721283.248	3389220.672
T-3	SITE B	CAMP	200.000	150.000	721319.500	3389237.577

Coord System window	**This drawing · PLANT ↔ UTM 38N · SITE A (PS3 ↔ UTM 38N) · SITE B (CAMP ↔ UTM 38N)**
Dual Draw · Pick site	**inside Site A → SITE A · between the sites → the drawing's system**

5 Common mistakes

- Linking a site to the wrong system: the label of A-1 then shows CAMP numbers. Open the site's **View** card and **Pick a point** A-1: X 520 Y 560 is right.
- Pressing Pick site while PLINE is running: it is refused. Pick the site first, then start the command.
- Typing PS3 numbers with the drawing's system chosen: the point lands far away (the plant system is used). Look at the row names (PLANT or PS3) before you type.
- Opening the .ctrans files in CSCOORD: they are opened in CTRANS (File...); CSCOORD then lists them.

6 Check yourself

With Site B chosen in Dual Draw you type CAMP X 150 Y 200. Which check point does the gold ring sit on, and what E / N does the other row show?

Answer: B-1 · E 721253.054 · N 3389261.762