

Project	Los Robles local road — Upgrading	Date	16 Oct 2026
Element	Subgrade, segment 0+000 – 0+220	Author	Eng. Ana Pérez

1 · Purpose and scope

To support the pricing of segment 0+000 – 0+220 of the Los Robles local road — Upgrading project, this report records the subgrade cut and fill volumes for progress certificate No. 2, period September 2026, set against the previously certified quantities. The volumes were computed by the average end area method over cross-sections. The geometry comes from the topographic survey of cross-sections and the volumetric factors from the project geotechnical study, as detailed in the input data.

2 · Input data

Parameter	Symbo	Value	Unit	Source
Cross-sections	n	12	sections	Topographic survey of cross-sections, 30 September 2026
Initial station	—	0+000.00	m	Topographic survey of cross-sections, 30 September 2026
Final station	—	0+220.00	m	Topographic survey of cross-sections, 30 September 2026
Length measured	L	220.00	m	Topographic survey of cross-sections, 30 September 2026
Swell factor	F_{sw}	1.25	—	Project geotechnical study
Shrinkage factor	F_{sh}	0.90	—	Project geotechnical study
Previous measurement	—	cut 1 032.20; fill 866.64	m ³	Progress certificate No. 1 (August 2026), approved

The cut and fill areas of each section are given in the earthwork quantity table in section 6.

3 · Assumptions

- Volume of each segment by the average end area method, which assumes a linear variation of the area between consecutive sections: the accuracy depends on the spacing between sections.
- The cut and fill areas of each cross-section are those given by the Author.
- Factors adopted: swell factor $F_{sw} = 1.25$ (loose volume / bank volume) and shrinkage factor $F_{sh} = 0.90$ (compacted volume / bank volume).
- Sign convention: the balance is cut minus fill; a positive value indicates surplus material and a negative one, a deficit. The mass haul diagram accumulates this balance in bank measure.
- Certificate by station: the previous volume of each segment is that of the previous measurement at the same station, or zero if the station is new; the progress for the period is the difference between the current and the previous volume. The volume of a segment of the previous measurement that does not appear in the current one is kept in the total.

4 · Methodology

Volume of the segment between sections i and i+1, a distance d apart:

$$V = \frac{A_i + A_{i+1}}{2} d$$

Adjusted volumes and mass haul ordinate at section k:

$$V_{\text{loose}} = F_{\text{sw}} V_c \quad V_{\text{bank}} = \frac{V_f}{F_{\text{sh}}} \quad M_k = \sum \left(V_c - \frac{V_f}{F_{\text{sh}}} \right)$$

Progress for the period in each segment:

$$\Delta V = V_{\text{current}} - V_{\text{previous}}$$

5 · Calculations

Sample segments; the others are calculated in the same way, and the full table is given in section 6:

Segment 0+000.00 – 0+020.00 (d = 20.00 m):

$$V_c = \frac{8.40 + 12.60}{2} \cdot 20.00 = \mathbf{210.00 \text{ m}^3} \quad V_f = \frac{0.00 + 0.50}{2} \cdot 20.00 = \mathbf{5.00 \text{ m}^3}$$

Segment 0+100.00 – 0+120.00 (d = 20.00 m):

$$V_c = \frac{1.20 + 0.00}{2} \cdot 20.00 = \mathbf{12.00 \text{ m}^3} \quad V_f = \frac{9.60 + 14.30}{2} \cdot 20.00 = \mathbf{239.00 \text{ m}^3}$$

Segment 0+200.00 – 0+220.00 (d = 20.00 m):

$$V_c = \frac{10.80 + 6.30}{2} \cdot 20.00 = \mathbf{171.00 \text{ m}^3} \quad V_f = \frac{0.40 + 0.00}{2} \cdot 20.00 = \mathbf{4.00 \text{ m}^3}$$

Totals:

$$\Sigma V_c = \mathbf{1\,469.00 \text{ m}^3} \quad \Sigma V_f = \mathbf{1\,016.00 \text{ m}^3} \quad B = 1\,469.00 - 1\,016.00 = \mathbf{453.00 \text{ m}^3}$$

Adjusted volumes:

$$V_{\text{loose}} = 1.25 \cdot 1\,469.00 = \mathbf{1\,836.25 \text{ m}^3} \quad V_{\text{bank}} = \frac{1\,016.00}{0.90} = \mathbf{1\,128.89 \text{ m}^3} \quad B_{\text{adj}} = 1\,469.00 - 1\,128.89 = \mathbf{340.11 \text{ m}^3}$$

6 · Results

Quantity	Value	Quantity	Value
Cut volume	1 469.00 m³	Loose cut, $F_{\text{sw}} \cdot V_c$	1 836.25 m³
Fill volume	1 016.00 m³	Bank material for the fill, V_f / F_{sh}	1 128.89 m³
Balance (cut – fill)	453.00 m³	Adjusted balance in bank measure	340.11 m³
Length measured	220.00 m	Cross-sections	12

EARTHWORK VOLUME CALCULATION REPORT

Earthworks · Progress certificate No. 2, period September 2026 — Average end areas

Eng. Ana Pérez

Earthwork quantity table (partial volumes of the segment ending at each station):

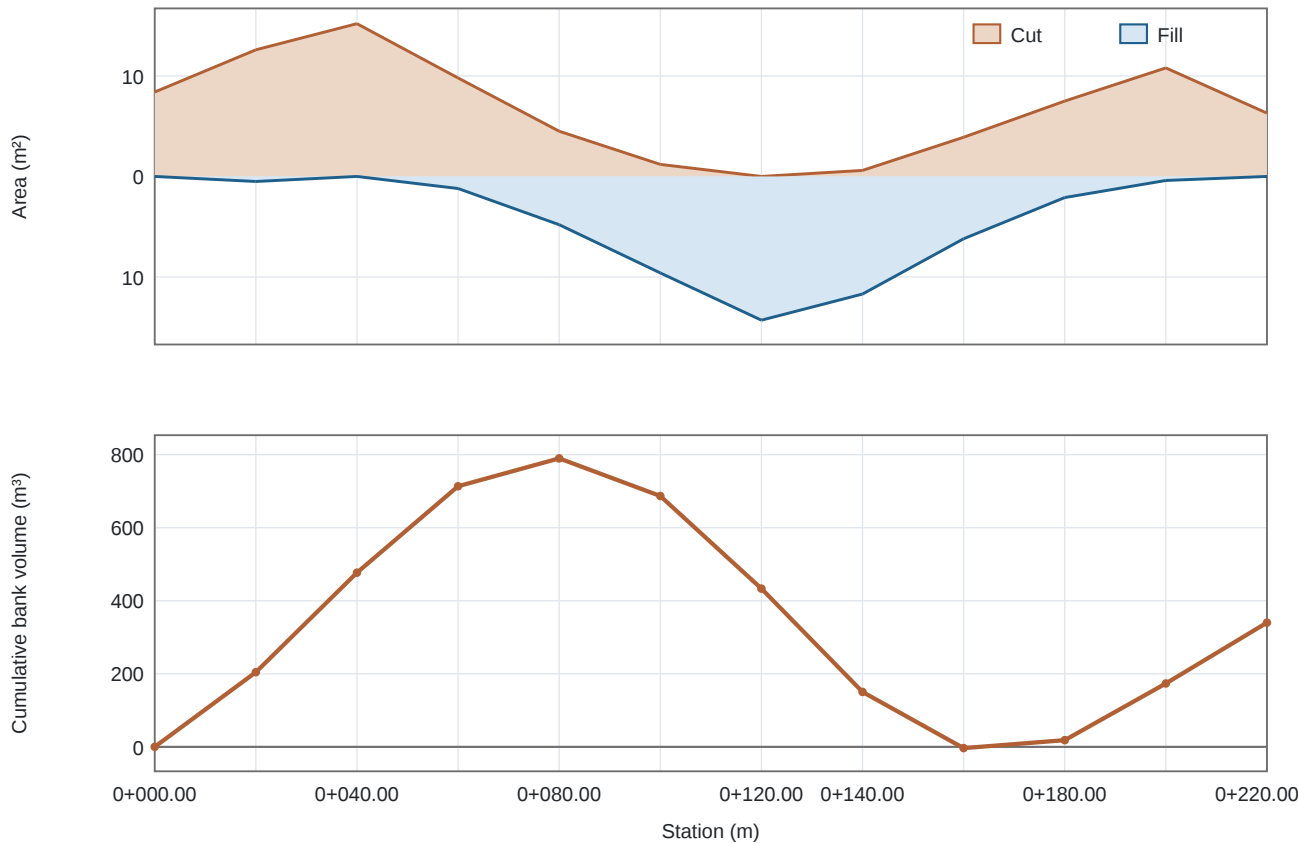
Station	A cut (m²)	A fill (m²)	d (m)	V cut (m³)	V fill (m³)	Σ cut (m³)	Σ fill (m³)	Mass (m³)
0+000.00	8.40	0.00	—	0.00	0.00	0.00	0.00	0.00
0+020.00	12.60	0.50	20.00	210.00	5.00	210.00	5.00	204.44
0+040.00	15.20	0.00	20.00	278.00	5.00	488.00	10.00	476.89
0+060.00	9.80	1.20	20.00	250.00	12.00	738.00	22.00	713.56
0+080.00	4.50	4.80	20.00	143.00	60.00	881.00	82.00	789.89
0+100.00	1.20	9.60	20.00	57.00	144.00	938.00	226.00	686.89
0+120.00	0.00	14.30	20.00	12.00	239.00	950.00	465.00	433.33
0+140.00	0.60	11.70	20.00	6.00	260.00	956.00	725.00	150.44
0+160.00	3.90	6.20	20.00	45.00	179.00	1 001.00	904.00	-3.44
0+180.00	7.50	2.10	20.00	114.00	83.00	1 115.00	987.00	18.33
0+200.00	10.80	0.40	20.00	183.00	25.00	1 298.00	1 012.00	173.56
0+220.00	6.30	0.00	20.00	171.00	4.00	1 469.00	1 016.00	340.11

Progress certificate No. 2, period September 2026 (volumes in m³):

Station	Cut previous	This period	Cut to date	Fill previous	This period	Fill to date
0+000.00	0.00	0.00	0.00	0.00	0.00	0.00
0+020.00	147.00	63.00	210.00	3.75	1.25	5.00
0+040.00	200.16	77.84	278.00	3.83	1.17	5.00
0+060.00	185.00	65.00	250.00	9.36	2.64	12.00
0+080.00	108.68	34.32	143.00	47.70	12.30	60.00
0+100.00	44.46	12.54	57.00	116.64	27.36	144.00
0+110.00	35.50	0.00	35.50	22.40	0.00	22.40
0+120.00	9.60	2.40	12.00	197.18	41.82	239.00
0+140.00	4.92	1.08	6.00	218.40	41.60	260.00
0+160.00	37.80	7.20	45.00	153.04	25.96	179.00
0+180.00	98.04	15.96	114.00	72.21	10.79	83.00
0+200.00	161.04	21.96	183.00	22.13	2.87	25.00
0+220.00	0.00	171.00	171.00	0.00	4.00	4.00
Total	1 032.20	472.30	1 504.50	866.64	171.76	1 038.40

The balance of the current measurement, cut minus fill, is a surplus of 453.00 m³ under the declared convention, in which a positive value denotes surplus material. Excavated soil swells and placed fill is compacted, so the volumetric factors bring both quantities to a common basis. The swell factor expresses the cut in loose measure, and the shrinkage factor gives the bank material required for the fill. On that basis, the adjusted balance in bank measure remains a surplus of 340.11 m³. The ordinates of the mass haul diagram are the cumulative balance in bank measure, with a minimum of -3.44 m³ against a maximum of 789.89 m³. Taken as the to-date value less the amount in the previous certificate, the period progress amounts to 472.30 m³ of cut and 171.76 m³ of fill.

7 · Mass haul diagram



Top: cut areas (upwards) and fill areas (downwards) by station. Bottom: mass haul diagram; a positive ordinate is cumulative surplus material and a negative one, a deficit.

8 · Conclusion

The current measurement of the segment gives 1 469.00 m³ of cut and 1 016.00 m³ of fill. This is a surplus of 453.00 m³, which becomes 340.11 m³ in bank measure once the volumetric factors are applied. Certificate No. 2, period September 2026, records to-date volumes of 1 504.50 m³ of cut and 1 038.40 m³ of fill, with a period progress of 472.30 m³ and 171.76 m³ respectively. The volumes result from the average end area method, whose precision depends on the spacing between sections.

9 · References

- Garber, N. J., and Hoel, L. A. (2009). *Traffic and Highway Engineering* (4th ed.). Cengage Learning. — Earthwork volumes by the average end area method, swell and shrinkage factors, and mass haul diagram.

Calculations, checks and report drafting carried out with HidraSoftware Calculators, based on the data and criteria defined by the Author, under whose professional responsibility this document is issued.