**Using the trapezoidal rule calculate the materials for an embankment**

# Worked example

You are tasked with designing a road that must pass through uneven terrain.

To create a level road, you will need to cut soil from higher areas and fill soil to lower areas.   
The elevations of the cross-section of the terrain along a 10-metre stretch of road are given in the table. The proposed new ground level on which the road will be constructed is at an elevation of 2 metres.

|  |  |  |
| --- | --- | --- |
| **Position (m)** | **Existing elevation (m)** | **Desired elevation (m)** |
| 0 | 2.5 | 2 |
| 2 | 3 | 2 |
| 4 | 2 | 2 |
| 6 | 1.5 | 2 |
| 8 | 1 | 2 |
| 10 | 1 | 2 |

**Step 1: Plot the x- and y-coordinates on graph paper.**

See the graph below.

**Step 2: Divide the base width of the cross-section into equal intervals.**

The base width is 10 m. The number of intervals is 5.

Therefore, the interval width is 10 ÷ 5 = 2 m.

**Step 3: Label the points where you will measure the ordinates.**

See the graph below.

A graph showing the cross-section of land.
The x-axis goes from 0 to 10, split into 2 metre intervals. It is labelled: distance along the road (m)
The y-axis goes from 0 to 3. It is labelled height above datum level (m).

The graph is a line graph in red called "existing terrain" starting at the point 0, 2.5. It connects to 2, 3, then to 4, 2, then to 6, 1.5, then to 8, 1 and finally to 10, 1.
There is a horizontal blue dashed line, called "proposed new ground level" from 2 on the y-axis across the width of the graph.

**Step 4: Measure the height of the cut or fill at each point.**

Each time, measure the height from the proposed finished level to the ordinate. The areas of cut are positive values as the heights are above the proposed new ground level.

The areas of fill are negative values as extra material is needed to fill in these sections.

**Step 5: Use the trapezoidal rule to calculate the area of cut and fill.**

interval width   
first ordinate   
sum of middle ordinates   
last ordinate

m2

As the result is negative, the fill area is greater than the cut area. The earthworks contractor will need to bring 1.5 m2 extra of earth per metre width of road.