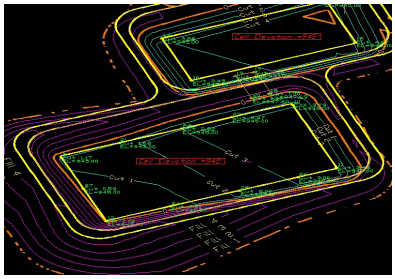
Cut and Fill Calculations

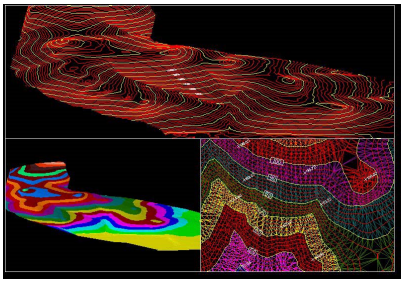
- Calculation of the cut-and-fill volumes is an essential component of any site development project



1

Cut and Fill Calculations

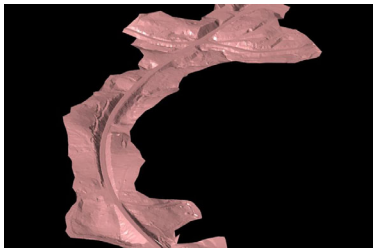
- Topographic data is required to estimate cut-and-fill volumes



2

Cut and Fill Calculations

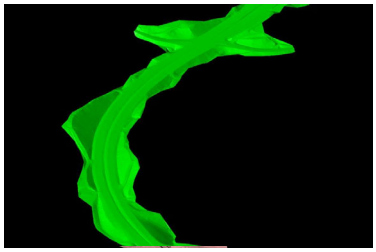
- Topographic data is required to estimate cut-and-fill volumes



3

Cut and Fill Calculations

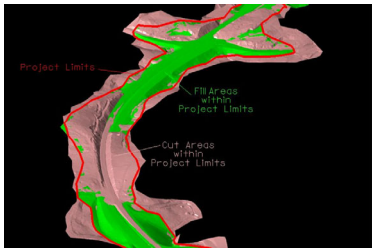
- Topographic data is required to estimate cut-and-fill volumes



4

Cut and Fill Calculations

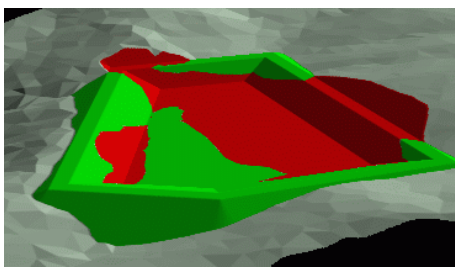
- Topographic data is required to estimate cut-and-fill volumes



5

Cut and Fill Calculations

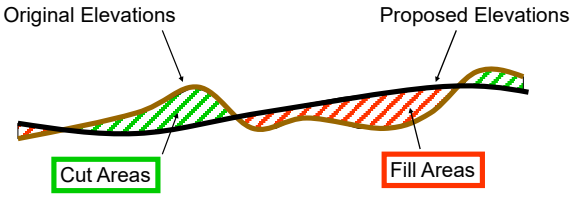
- Topographic data is required to estimate cut-and-fill volumes



6

Cut and Fill Calculations

- From the topographic data of the site, different alternative site plans can be evaluated
- The basic calculation is the difference between the desired elevation and the original elevation



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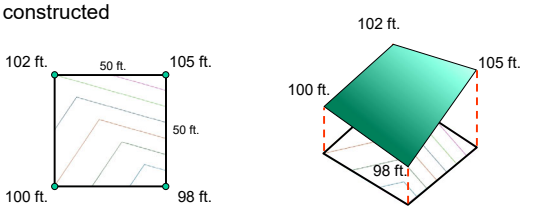
Cut and Fill Calculations

- Traditionally, elevations for a topographic survey are collected using some regular grid system
- Using the elevation data and the grid system, a three-dimensional model of the cut-and-fill volumes can be constructed



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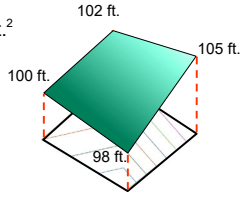
Cut and Fill Calculations

- The volume of material in this grid cell may be estimated as the volume of the quadrilateral cell
- Volume equals the average of the cell height times the area of the cell

$$\text{Cell Area} = (50\,\text{ft.})(50\,\text{ft.}) = 2{,}500\,\text{ft.}^2$$

$$\text{Volume} = \left(\frac{98+100+102+105}{4}\right)\text{ft.}\,(2{,}500\,\text{ft.}^2)$$

$$\text{Volume} = 253{,}125\,\text{ft.}^3 = 9{,}375\,\text{yd.}^3$$



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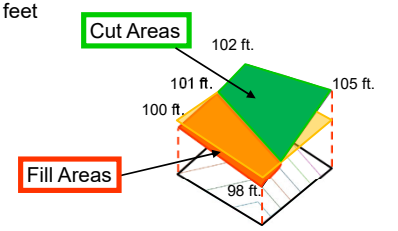
Cut and Fill Calculations

- Consider a cell in the grid system with the following elevations
- Development at this site requires that this area be at an elevation of 101 feet



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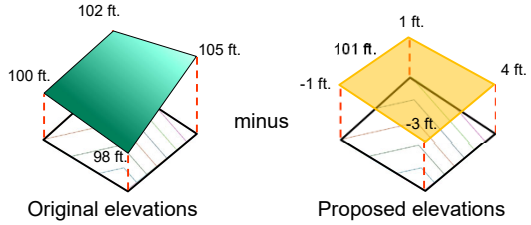
Cut and Fill Calculations

- To estimate the cut-and-fill required in this cell, first compute the change in volume
- ΔV = original elevations - proposed elevations



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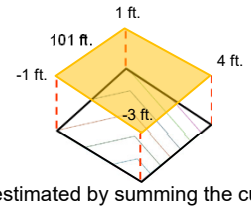
Cut and Fill Calculations

- The volume of cut-and-fill in this grid cell may be estimated as the volume of the quadrilateral cell
- Volume equals the average of the cell height times the area of the cell

$$\text{Cell Area} = (50\,\text{ft.})(50\,\text{ft.}) = 2{,}500\,\text{ft.}^2$$

$$\text{Volume} = \left(\frac{-3-1+1+4}{4}\right)\text{ft.}\,(2{,}500\,\text{ft.}^2)$$

$$\text{Volume} = 625\,\text{ft.}^3 = 23.15\,\text{yd.}^3$$



- The total cut-and-fill can be estimated by summing the cut-and-fill from each cell for the entire grid system

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Cut and Fill Calculations

- Compute the total cut-and-fill for the following site
- The original elevations are:

	1	2	3	4	5
1	105	104	104	103	102
2	104	104	103	102	101
3	103	103	102	101	100
4	103	102	101	100	99
5	101	100	99	98	97

- The size of each cell is 25 ft. by 25 ft.
- The proposed site is at an elevation of 101 ft.

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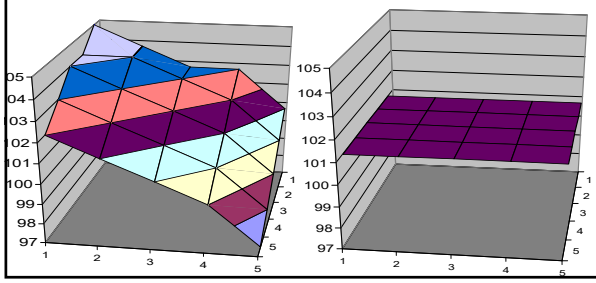
Cut and Fill Calculations

- Below is an Excel plot of the original elevations and the proposed elevations



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Cut and Fill Calculations

- Compute the elevation change:
  original elevations – proposed elevations

	1	2	3	4	5
1	105	104	104	103	102
2	104	104	103	102	101
3	103	103	102	101	100
4	103	102	101	100	99
5	101	100	99	98	97

- In this case, the proposed elevations are 101 ft. for the entire site.
- In general, the proposed elevations vary over the site.

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Cut and Fill Calculations

- Compute the elevation change:
  original elevations – proposed elevations

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	104	104	103	102	101
3	103	103	102	101	100
4	103	102	101	100	99
5	101	100	99	98	97

- Let's consider the change in elevation for the 1st row

16

Cut and Fill Calculations

- Compute the elevation change:
  original elevations – proposed elevations

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	104	104	103	102	101
3	2.00	2.00	1.00	0.00	-1.00
4	103	102	101	100	99
5	101	100	99	98	97

- Let's consider the change in elevation for the 2nd row

17

Cut and Fill Calculations

- Compute the elevation change:
  original elevations – proposed elevations

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	104	104	103	102	101
3	2.00	2.00	1.00	0.00	-1.00
4	103	102	101	100	99
5	0.00	-1.00	-2.00	-3.00	-4.00

- Let's consider the change in elevation for the 3rd row

18

Cut and Fill Calculations

- Compute the elevation change:
  original elevations – proposed elevations

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- Positive (+) values indicate cut and negative (-) values indicate fill.

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Cut and Fill Calculations

- Compute the volume of cut-and-fill for each grid cell
- Average the elevations for each grid cell times the cell area

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(4+3+3+3)\text{ft.}}{4}(625\,\text{ft.}^2) = 2{,}031.3\,\text{ft.}^3 = 75.23\,\text{yd.}^3$$

20

Cut and Fill Calculations

- For the cell to the right, compute the volume of cut-and-fill

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(3+3+3+2)\text{ft.}}{4}(625\,\text{ft.}^2) = 1{,}718.8\,\text{ft.}^3 = 63.66\,\text{yd.}^3$$

21

Cut and Fill Calculations

- For the cell to the right, compute the volume of cut-and-fill

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(3+2+2+1)\text{ft.}}{4}(625\,\text{ft.}^2) = 1{,}250\,\text{ft.}^3 = 46.30\,\text{yd.}^3$$

22

Cut and Fill Calculations

- For the cell to the right, compute the volume of cut-and-fill

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(2+1+1+0)\text{ft.}}{4}(625\,\text{ft.}^2) = 625\,\text{ft.}^3 = 23.15\,\text{yd.}^3$$

23

Cut and Fill Calculations

- For the cell to the right, compute the volume of cut-and-fill

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(3+3+2+2)\text{ft.}}{4}(625\,\text{ft.}^2) = 1{,}562.5\,\text{ft.}^3 = 58.87\,\text{yd.}^3$$

24

Cut and Fill Calculations

- The resulting cut-and-fill volumes (yd.^{3}) for each cell in the entire grid system is:

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- A sited model with a 5 x 5 grid system contains 4 x 4 cells

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Cut and Fill Calculations

- The total cut-and-fill for this site may be estimated by summing the cut-and-fill volumes for each cell

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- For this example, the total is: 284 yd.^{3}
- Use Excel function: =sum(A1:D4)

26

Cut and Fill Calculations

- The total cut this site may be estimated by summing the positive (+) cut-and-fill volumes for each cell

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- For this example, the total is: 411 yd.^{3}
- Use Excel function: =sumif(A1:D4,">0")

27

Cut and Fill Calculations

- The total fill this site may be estimated by summing the negative (-) cut-and-fill volumes for each cell

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- For this example, the total is: -127 yd.^{3}
- Use Excel function: =sumif(A1:D4,"<0")

28

Cut and Fill Calculations

- An estimate of the cost of cut-and-fill for the entire site can be made by considering:
- On-site cost ($2.50/yd.^{3}) for total cut-and-fill volume:

$$\text{On site} = \left(\frac{\$2.50}{\text{yd.}^3}\right)[cut - fill] = \left(\frac{\$2.50}{\text{yd.}^3}\right)[411-(-127)]\,\text{yd.}^3$$

$$\text{On site} = \$1{,}345$$

- Note: since fill volume is always (-) negative, to compute the total earthwork volume use (cut – fill)

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Cut and Fill Calculations

- An estimate of the cost of cut-and-fill for the entire site can be made by considering:
- Off-site cost: $5/yd.^{3} for fill and $3/yd.^{3} for cut

$$\text{Off site} = \left(\frac{\text{cost}}{\text{yd.}^3}\right)|cut + fill| = \left(\frac{\text{cost}}{\text{yd.}^3}\right)|411-127|\,\text{yd.}^3$$

$$\text{Off site} = \left(\frac{\$3}{\text{yd.}^3}\right)|284\,\text{yd.}^3| = \$852$$

$$\text{Total Cost} = \$1{,}345 + \$852 = \boxed{\$2{,}197}$$

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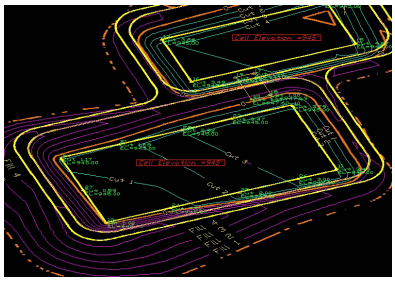
End of Cut-and-Fill 1



Any Questions?

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