

Where Can the Gym Go? Reading a Fault Trench Before Building

Learning target: I can use cross-cutting relationships in a trench log to decide whether a fault has moved recently, evaluate three building plans against criteria and constraints, and justify a recommendation.

Transfer and design

About 50 min

Pairs

MS-ESS1-4 · practice

MS-ESS2-2 · practice

MS-ETS1-2 · assesses

engineering design

data analysis

writing

Name _____

Date _____

Period _____

Directions

Read the problem, the criteria and constraints, and the trench log. Part A asks you to decide, from the trench, whether the fault counts as active. Part B asks you to evaluate three site plans with a scoring matrix and choose one. Part C asks for a site plan sketch and a justification written for the school board, who are not scientists. Everything you need is on this sheet; the school, the lot and the trench are invented, but the law and the method are real.

You will need: This worksheet, Pencil, Ruler, Colored pencil for the setback band

The problem

Alder Creek Middle School (invented) wants to build a new gym on an empty lot east of the main building. The lot is 120 m long from west to east and 60 m wide from north to south; the main building stands along the lot's west edge. A state map shows a fault trace crossing the lot from north to south, about 45 m from the west edge, but the map is only accurate to about 10 m either way. California's Alquist-Priolo Earthquake Fault Zoning Act does not allow a building for people to sit on top of an **active** fault, meaning one that has moved in roughly the last 11,700 years. The usual rule is a setback of 15 m (50 feet) on each side of an active fault trace. To find out whether the fault is active and exactly where it runs, the district dug a trench across the lot and logged the layers in its wall.

Criteria and constraints — Criteria (what a good plan does): 1. The gym is at least 15 m from the fault trace on every side. 2. Students can walk from the main building to the gym in under 90 seconds (about 100 m). 3. Total cost is as low as possible. Constraints (what cannot change): the gym is 40 m by 25 m and can be turned either way; it must fit inside the lot; the budget is 6.0 million dollars; the trench results below are the only fault evidence available.

Trench log (teaching data; layers listed from the ground surface downward)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Layer	Depth below surface (m)	Material	Age of charcoal in the layer	Broken by the fault?
1	0 to 0.4	Dark topsoil	none found	No; runs across unbroken
2	0.4 to 1.2	Tan silt	about 2,500 years	No; runs across unbroken
3	1.2 to 2.0	Gravel	about 9,000 years	Yes; offset 0.3 m
4	2.0 to 3.5	Gray clay	about 18,000 years	Yes; offset 0.9 m
5	3.5 to 5.0	Brown sand	none found	Yes; offset 0.9 m

The fault was found in the trench wall 52 m from the west edge of the lot. Charcoal ages come from a lab method for young carbon-containing material that this lesson does not cover; treat them as given. Offsets are how far the layer on one side of the fault sits above its match on the other side.

Part A: Is the fault active?

1. Which layers does the fault cut, and which lie across it unbroken? Using the law of cross-cutting relationships, state the youngest layer the fault is known to have moved and the oldest layer that proves it has not moved since. 2 pts

2. Between what two ages did the fault last move? Explain how each limit comes from the trench log. 2 pts

3. Layer 4 is offset 0.9 m but layer 3 is offset only 0.3 m. How much of the 0.9 m happened before layer 3 was deposited, and how much after? What does this tell you about the number of times the fault has moved? 2 pts

4. Does the fault count as active under the 11,700-year rule? Explain using your answer to q2, and say why the exact location found in the trench (52 m) matters more than the map's 45 m. 2 pts

Part B: Evaluate three plans

Three proposed site plans (distances measured from the lot's west edge)

Plan	Gym position and orientation	Nearest gym wall to the fault (at 52 m)	Walk from main building	Estimated cost	Notes
1	Centered on the lot, long side west-east: 40 m to 80 m	0 m (the fault runs under the gym)	40 m	5.1 million dollars	Flat ground; shortest utility lines
2	East side, long side west-east: 70 m to 110 m	18 m	70 m	5.3 million dollars	Flat ground; needs a longer path and utility line
3	West side, turned so the short side faces west-east: 5 m to 30 m	22 m	5 m	5.9 million dollars	Ground slopes; needs cutting and filling before building

5. Score each plan on each criterion: 2 = fully meets, 1 = partly meets, 0 = fails. Write 'X' in any cell where the plan breaks a constraint. Add a total for each plan. 4 pts

Criterion	Plan 1	Plan 2	Plan 3
1. At least 15 m from the fault on every side			
2. Walk under 100 m			
3. Lowest cost			
Any constraint broken? (X)			
Total			

6. Which plan do you recommend? If two plans tie or come close, explain what tipped your decision and which criterion you treated as most important. 2 pts

7. Plan 2's nearest wall is 18 m from the trench location of the fault. Suppose a second trench 30 m to the north found the fault at 58 m instead of 52 m. Would Plan 2 still meet criterion 1? Show the subtraction and state what you would recommend. 2 pts

Part C: Site plan and justification

8. Draw the lot to scale (1 cm = 10 m): a 12 cm by 6 cm rectangle. Mark the main building along the west edge, the fault trace at 52 m, a shaded 15 m setback band on each side of the fault, and your recommended gym as a rectangle in the correct position and orientation. Label the distance from the gym's nearest wall to the fault. 3 pts



9. Write a paragraph for the school board (five to seven sentences) that: states whether the fault is active and the trench evidence for it, in words a non-scientist can follow; recommends a plan; explains what the plan gives up compared with the others; and names one more piece of evidence the district should gather before building. 5 pts

Read the trench like a cliff

The trench wall is a tiny version of the road cuts in this chapter. The rule is the same: a fault is younger than every layer it breaks and older than every layer that lies across it unbroken. Mark each row of the log with B (broken) or U (unbroken). The last movement happened after the youngest B layer formed and before the oldest U layer formed. For the matrix, do criterion 1 first; any plan that fails it is out, whatever its other scores.

Narrowing the window

The trench shows the fault last moved between about 9,000 and 2,500 years ago, a window of 6,500 years. Describe what a geologist could look for in a deeper or longer trench to narrow that window (think about finding and dating a layer between layers 2 and 3, or a thin layer that is broken by only a tiny amount). Then explain why the district would care whether the last movement was 8,900 years ago or 2,600 years ago, even though both count as active.