

Three Crossings, One Bridge: Rank the Sites by Hazard Risk

Investigation question: Which of three possible crossings of the fictional Rio Ventana should carry the new lifeline bridge to the county hospital, and what must the design include there, given each site's earthquake, ground, volcano and tsunami data and a 90 million dollar budget?

Data-driven decision

Groups of 4

1 session

Setup 5 · Activity 50 · Cleanup 2 min

MS-ESS3-2 · assesses

MS-ETS1-1 · practice

MS-ETS1-2 · practice

Scientific purpose

Ventana County (fictional) must build one bridge on the only ambulance route to its regional hospital. Three crossings are possible: one near a restless volcano, one in a bedrock gorge beside an active fault, and one on soft mud near the coast above an offshore subduction zone. Students turn a simulated earthquake catalog into frequencies, compare magnitudes logarithmically, score five hazards at each site with stated rules, rank the sites, check what a lifeline design and the site fixes would cost, and recommend a site. The lab applies both halves of MS-ESS3-2 (analyze hazard data to forecast, then choose mitigation) and makes students confront the difference between how hazardous a site is and how much of that hazard engineering can actually reduce.

Why this helps students with this chapter

Hazard maps and catalogs are only useful if someone turns them into a decision. Scoring each hazard separately makes students use frequency, magnitude, intensity and ground type together instead of reacting to the most dramatic fact (a fault 1.5 km away). The budget then forces a real trade-off: the site with the lowest total score is not automatically right, and the most hazardous site may simply be unaffordable. Students finish knowing why engineers can design for shaking but cannot design away every hazard.

Standards connections

MS-ESS3-2 (assesses, both halves: analyzing frequency, magnitude, location and ground data to forecast hazards at each site, and using the forecast to choose mitigation): Students compute earthquake frequencies from a catalog, compare magnitudes, weigh the chances of rare great earthquakes, mudflows and tsunamis, rank three sites, and choose a site and mitigation measures within a budget (q1 to q6). The data are simulated, but the task is the analysis-and-mitigation reasoning the PE describes.

MS-ETS1-1 (practice, site hazards as scientific constraints on a design, and the hospital route as a criterion based on impacts on people): The lifeline criterion comes from what people need after an earthquake, and each site's hazards limit which designs can succeed and what they cost. The criteria are supplied, so students practice applying them rather than defining them from scratch.

MS-ETS1-2 (practice, evaluating competing sites with a systematic scoring table and a cost check): The scoring table and cost table are a systematic process for comparing three competing solutions against the criteria and constraints; q7 asks students to evaluate the scoring method itself.

Roles (rotate each session)

- **Seismic analyst:** Works the earthquake catalog: frequencies, the magnitude comparison and the two shaking rows of the scoring table.
- **Ground and volcano analyst:** Scores the ground-failure, volcanic and tsunami rows and explains each score to the group.
- **Cost engineer:** Fills the cost table for every site, checks each total against the budget, and flags any hazard the site fixes cannot fully remove.
- **Decision lead:** Runs the final discussion, drafts the recommendation from the group's numbers, and presents it to the class in under two minutes.

Materials

Item	Quantity	Per	Note
Recording sheet with the site description, both datasets, scoring rules, scoring table, cost menu and cost table	1	student	
Calculator	1	group	
Colored pencils (five colors, one per hazard) for the stacked bar graph	1 set	group	
Pencil with eraser	1	student	

Estimated cost: 2 to 4 per class (estimate) (an estimate; Printing only; calculators and colored pencils are classroom stock.)

Safety

- Paper and calculator only; there are no physical hazards.
- Ventana County, its fault, volcano and sites are fictional and every number is simulated. Remind students not to draw conclusions about real places from this dataset; real hazard maps come from the USGS and the California Geological Survey.

Teacher preparation and setup

1. Score all three sites yourself with the rules (reference totals: Site A 17, Site B 14, Site C 28) and fill the cost table (lifeline totals: A 85, B 88, C 162 million dollars) so you can spot slips quickly.
2. Print the recording sheet double-sided. Draw a large copy of the scoring table on the board for the debrief.
3. Decide whether to run Lab 2 first. The lifeline targets here are the same ones Lab 2 groups built to, so students who did Lab 2 already know what a lifeline design must achieve.
4. Be ready for students who have lived through an earthquake, wildfire or evacuation. Keep the discussion about the fictional county and the engineering, and let students opt out of sharing personal stories.

Investigation design

Independent variable	The candidate site (A, B or C), each with its own catalog, ground type, distances to hazard sources and costs.
Dependent variable	Each site's hazard scores (likelihood x severity for five hazards), total hazard score, and lifeline cost compared with the budget.
Controlled	The same scoring rules for every site; The same 100-year catalog period and 50 km search radius; The same bridge purpose and lifeline targets; The same budget and cost rules
Trials	One full scoring and costing of three sites per group; groups compare totals and recommendations in the debrief.
Comparison	Sites are compared by total hazard score, by which hazard dominates, by whether the dominant hazard can be engineered for, and by cost against the budget.

Student procedure

1. Read the scenario, the criteria and the budget together. Make sure everyone can say what a lifeline bridge must do (no damage in frequent shaking, minor damage at most and still open after rare strong shaking, usable by emergency vehicles after the strongest shaking).
2. Seismic analyst leads q1 to q4: convert the catalog into M5.0+ earthquakes per decade at each site, then compare the two great-earthquake sources logarithmically and explain why two different sources can give the same intensity.
3. Score every hazard at every site using the scoring rules exactly as written. Each analyst scores their own rows and the group checks each other's work. Add up each site's total.
4. Draw a stacked bar graph of the totals, one color per hazard, so the group can see which hazard dominates each site. Answer q5.
5. Cost engineer fills the cost table for a lifeline bridge at every site, including the site fixes, and checks each total against the 90 million dollar budget.
6. Discuss and decide. Which site would you recommend, and why? Name at least one hazard that remains even after the fixes. Write the recommendation (q6) and present it.
7. Answer the analysis questions individually.

Expected observations

- Frequencies of M5.0+ earthquakes: A 0.6, B 1.7 and C 0.7 per decade.
- Scores: $A = 4 + 3 + 4 + 6 + 0 = 17$; $B = 3 + 9 + 1 + 1 + 0 = 14$; $C = 6 + 6 + 9 + 1 + 6 = 28$. Ranking C, A, B.
- Lifeline costs: $A = 40 + 20 + 25 = 85$, $B = 56 + 28 + 4 = 88$, $C = 80 + 40 + 42 = 162$ million dollars; only A and B fit the budget.
- Most groups recommend Site B, arguing that its dominant hazard is the one a lifeline design is built for; some argue for A as the cheapest affordable site and must address the mudflow risk.

Likely difficulties

- Counting only the 5.0 to 5.9 row for q1 and forgetting the 6.0 to 6.9 row (B becomes 1.4 instead of 1.7).
- For Site C's strongest-shaking row, scoring the two sources and adding them instead of taking the larger, as the rule says.
- Treating the total score as the decision. Ask what the score cannot tell you (cost, whether the hazard can be engineered for).
- Adding the magnitude difference instead of using powers in q3 (answering 1.5 times or 48 times).
- Reading 'about 40 percent in 100 years' as 'it will happen in 40 years'.

Structured debrief

1. Put every group's totals on the board. They should agree (A 17, B 14, C 28); where they do not, trace the difference to one rule. Then show the stacked graph: Site C's score comes from three different hazards (ground failure, tsunami and shaking on soft mud), Site A's is dominated by the volcano, and Site B's by one row, strongest shaking.
2. Reveal the costs: only A (85) and B (88) fit the budget. Ask the A and B camps to argue. The key idea: a lifeline design exists to handle shaking, B's dominant hazard, while A's dominant hazard, a mudflow, can be reduced by longer spans but not removed, and the road to the hospital is most needed during an eruption emergency. Most groups should land on B; credit an A recommendation only if it deals honestly with the mudflow risk.
3. Connect to California. Site B resembles crossings of the San Andreas or Hayward Fault zones on firm ground; Site C resembles soft bay-mud sites such as the approaches to the Bay Bridge, where the 1989 shaking was amplified, and the Cascadia coast with its tsunami zone; Site A resembles valleys below Mount Shasta or Lassen Peak, where old mudflow deposits are mapped. The real Bay Bridge eastern span was built on a bay-mud site anyway, because it had to cross there; it is designed to reopen quickly after the strongest shaking expected in about 1,500 years.
4. Close on forecasting versus prediction (q8): every chance in this lab came from average intervals, and averages are not schedules. That is exactly why engineers design for a level of shaking instead of a date.

Recording sheet: what students fill in

Lab 3 recording sheet: Three Crossings, One Bridge

Ventana County is **fictional**, and every number below is a **teaching dataset**. The Rio Ventana flows west from Mount Ventana, a volcano that has been restless lately, to the sea. The Ventana Fault, a strike-slip fault like the San Andreas, runs north-south through the middle of the county, and an offshore subduction zone lies 60 km west of the coast. The county will build **one** bridge on the only ambulance route to its regional hospital, so it must be a **lifeline** bridge: no damage in frequent moderate shaking, minor damage at most and still open after rare strong shaking, and usable by emergency vehicles after the strongest shaking.

Budget: 90 million dollars. Risk combines a hazard with what is exposed to it. The same bridge would carry the same traffic at any site, so comparing hazards here also compares risks.

Earthquakes within 50 km of each site in the last 100 years

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

Magnitude range	Site A: Upper Ford	Site B: Middle Gorge	Site C: Bay Mouth
4.0 to 4.9	52	75	28
5.0 to 5.9	6	14	6
6.0 to 6.9	0	3	1
7.0 or more	0	0	0
Largest recorded	5.6	6.8	6.2

Simulated teaching data. Most of Site A's small earthquakes come from swarms beneath Mount Ventana.

Site profiles

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

Feature	Site A: Upper Ford	Site B: Middle Gorge	Site C: Bay Mouth
Ground under the bridge supports	Loose sand and gravel from old mudflows, beside the river	Solid bedrock gorge	Soft bay mud and artificial fill
Distance to the Ventana Fault	25 km	1.5 km (the fault does not cross the site)	35 km
Strongest expected shaking: source	Ventana Fault, magnitude 7.5	Ventana Fault, magnitude 7.5	Offshore subduction zone, magnitude 9 (60 km away)
Chance of that shaking in the next 100 years	about 40 percent	about 40 percent	about 20 percent
Expected intensity at the site	VII	IX	IX
Second shaking source	none	none	Ventana Fault, magnitude 7.5: about 40 percent, intensity VIII
Distance to Mount Ventana	14 km	32 km	55 km
Volcanic mudflow (lahar) layers found at the site, last 2,000 years	5	0	0
Chance a mudflow or thick ash reaches the site in 100 years	about 20 percent (mudflow)	about 5 percent (ash only)	about 3 percent (ash only)

Feature	Site A: Upper Ford	Site B: Middle Gorge	Site C: Bay Mouth
In the mapped tsunami zone?	No	No	Yes (from the great subduction earthquake, about 20 percent in 100 years)
Bridge length needed	90 m	140 m	300 m

Simulated teaching data. Chances come from average intervals in the geologic record (for example, 6 ruptures of the Ventana Fault in 1,200 years; 7 great subduction earthquakes in 3,500 years) and are estimates, not schedules.

- For each site, find the number of magnitude 5.0 or larger earthquakes in the 100-year catalog and convert it to earthquakes per decade. Show your work.

Answer: A: $6 + 0 + 0 = 6$ earthquakes in 100 years $= 6 / 10 = 0.6$ per decade. B: $14 + 3 + 0 = 17$ in 100 years $= 1.7$ per decade. C: $6 + 1 + 0 = 7$ in 100 years $= 0.7$ per decade.

Why: Magnitude 5.0 or larger includes the 5.0-5.9, 6.0-6.9 and 7.0+ rows; 100 years is 10 decades.

- Includes all rows at or above 5.0
- Divides by 10 decades
- 0.6, 1.7 and 0.7

- Which site has the most frequent moderate earthquakes? Give one reason why that alone does not make it the most hazardous site for the bridge.

Answer: Site B, with 1.7 M5.0+ earthquakes per decade. Frequency alone does not decide the hazard because the ground matters (B sits on bedrock, which shakes least), the rarest events can matter more than frequent moderate ones (C faces a magnitude 9 and a tsunami), and other hazards (mudflows at A, liquefaction at C) are not earthquakes at all.

Why: Any one valid reason earns credit.

- Identifies Site B with its frequency
- Gives one valid reason (ground type, rare large events, other hazards)

- Site C's great-earthquake source is magnitude 9 and Site B's is magnitude 7.5. About how many times more energy does the magnitude 9 release? (Hint: the difference is 1.5 steps. One step multiplies energy by about 32; half a step multiplies it by about 5.6.)

Answer: Difference $= 9 - 7.5 = 1.5$ steps. Energy factor: one step gives about 32 times and the extra half step about 5.6 times, so $32 \times 5.6 =$ about 180 times. (Exactly: 10 to the power $1.5 \times 1.5 = 10$ to the power $2.25 =$ about 178.)

Why: Each step multiplies energy by about 32 (10 to the power 1.5), so 1.5 steps multiplies it by 10 to the power $1.5 \times 1.5 = 10$ to the power 2.25. The ground motion recorded at the same distance would be about 32 times larger (10 to the power 1.5).

Also acceptable: Accept 'between 100 and 1,000 times, closer to 200' with reasoning from the one-step (32) and two-step (1,000) values.

- Finds a 1.5-step difference
- About 150 to 200 times the energy
- Work shown

4. Even though the magnitude 9 releases far more energy, both sites expect intensity IX. Use distance and ground type to explain how that can be true.

Answer: Shaking weakens with distance from the source. Site B is only 1.5 km from the Ventana Fault, so it feels the magnitude 7.5's shaking almost at full strength on bedrock. Site C is 60 km from the subduction zone, so the shaking has weakened by the time it arrives, but C sits on soft mud and fill, which amplifies shaking. Magnitude describes the earthquake's size at the source; intensity describes shaking at one place, which depends on distance and ground.

Why: This is the magnitude-versus-intensity distinction applied to data.

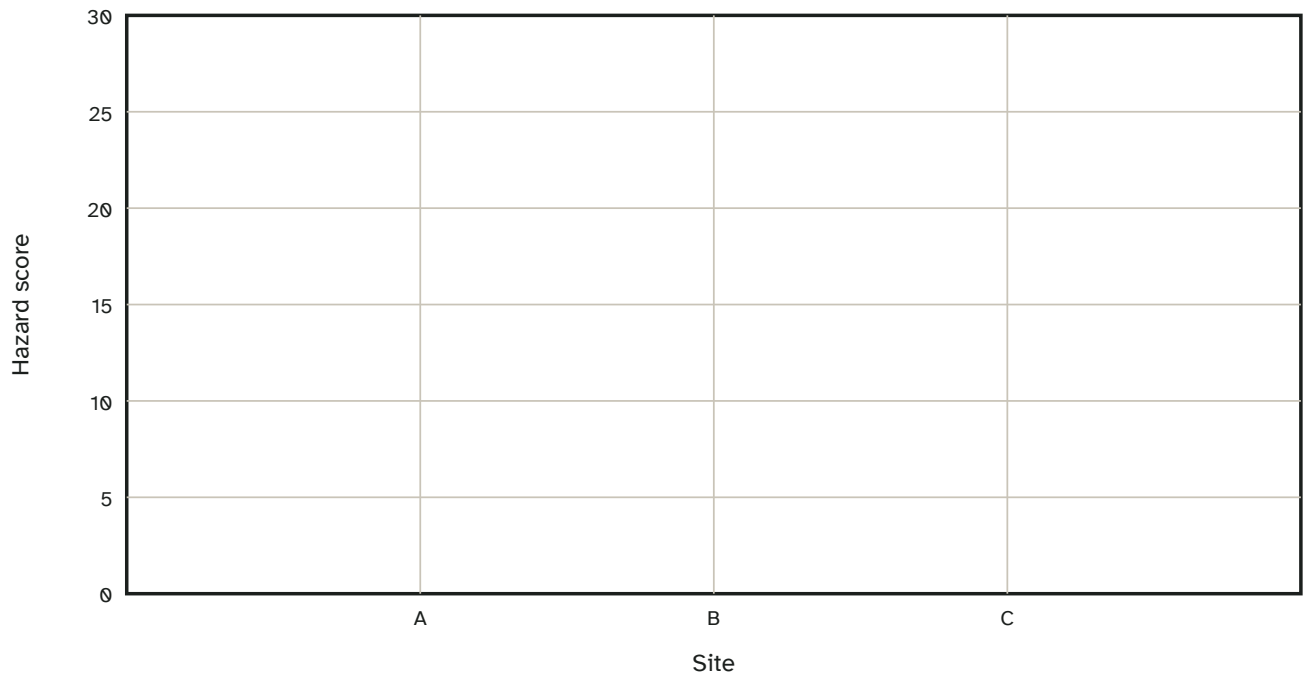
- Uses distance (1.5 km vs 60 km)
- Uses ground type (bedrock vs soft mud)
- Distinguishes magnitude from intensity

Scoring rules: score = likelihood (L) x severity (S) — Likelihood from a chance in 100 years: under 10 percent = 1; 10 to 30 percent = 2; over 30 percent = 3. **1. Frequent shaking:** L from the number of M5.0+ earthquakes in the catalog (0 = 0, 1 to 5 = 1, 6 to 15 = 2, 16 or more = 3); S from the ground (bedrock = 1, sand and gravel = 2, soft mud or fill = 3). **2. Strongest shaking:** L from its chance; S from the intensity (VII or less = 1, VIII = 2, IX or more = 3). If a site has two sources, score both and use the larger. **3. Ground failure** (liquefaction or rockfall): bedrock L = 1, S = 1; loose sand and gravel beside water L = 2, S = 2; soft mud or fill L = 3, S = 3. **4. Volcanic:** L from the chance; S = 3 if a mudflow reaches the site, 1 for ash only. **5. Tsunami:** 0 outside the zone; inside, L from the chance and S = 3.

Hazard scoring table

[illegible]

Total hazard score by site (stack the five hazards, one color each)



5. Rank the three sites from highest to lowest total hazard score. For each site, which single hazard contributes the most?

Answer: C (28), then A (17), then B (14). Largest single contributor: C, ground failure on soft mud and fill (9); A, volcanic mudflows (6); B, the strongest shaking from the nearby Ventana Fault (9).

Why: Read directly from the scoring table.

- Correct order with totals
- Correct dominant hazard for each site

Cost menu (millions of dollars)

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

Item	Site A	Site B	Site C
Basic bridge for the length needed	40	56	80
Lifeline upgrade for shaking (add 50 percent of the basic cost)	add 50%	add 50%	add 50%
Site fixes (needed at every performance level)	Longer, higher spans to keep supports out of the mudflow channel: 25	Rockfall netting and anchors on the gorge walls: 4	Ground improvement and deep piles: 30; tsunami-resistant supports and raised approaches: 12
What the fixes cannot remove	A very large mudflow can still bury the approach roads	Shaking itself, which the lifeline design is built to handle	Some settling of the approaches on soft ground

Simulated teaching data. Costs are invented round numbers for a fictional county.

Cost table for a lifeline bridge

Cost item	Site A	Site B	Site C
Basic bridge			
Lifeline upgrade			
Site fixes			
Total			
Within the 90 million dollar budget? (Y/N)			

6. Recommendation. Which site should the county choose? Use your scores, your cost table and at least one calculation. Explain why you rejected the other two sites, and name one hazard that remains at your chosen site even after the fixes.

Answer: Recommended: Site B. Its total hazard score is the lowest (14), its lifeline cost (88 million dollars) is within the budget, and its dominant hazard, strong shaking from the Ventana Fault (score 9; about a 40 percent chance in 100 years of intensity IX), is exactly what a lifeline design is built to survive; bedrock means little ground failure. Site C is rejected because its lifeline cost (162 million) is far over budget and it has the highest score (28) from three hazards at once (liquefaction, tsunami and amplified shaking). Site A fits the budget (85 million) but scores higher (17) and its dominant hazard, mudflows from a restless volcano (about 20 percent in 100 years), can be reduced but not removed: a large mudflow could still bury the approaches, cutting the hospital route during an eruption emergency, when it is needed most. Remaining hazard at B: very strong shaking could still damage the bridge (the lifeline target allows damage limited to emergency use only in the very rarest shaking), and rockfall from the gorge walls is reduced, not eliminated.

Why: B is the most defensible choice. An A recommendation can earn partial to full credit only if it uses numbers, acknowledges that the mudflow hazard cannot be fully engineered away and explains how monitoring and warning would protect the route.

Also acceptable: Site A with an honest treatment of the mudflow risk, a monitoring and warning plan, and the cost advantage (3 million dollars cheaper).

- Names a site within budget, citing its total score and cost
- Uses at least one calculation (frequency, energy ratio or cost)
- Explains why each other site was rejected with data
- Names a hazard that remains after the fixes

Analysis questions: answer key

7. Site B is only 1.5 km from the Ventana Fault, yet it has the lowest total score. Explain why, and describe one thing the total score hides that an engineer would still care about.

Answer: Site B's total is low because it has essentially one serious hazard: strong shaking (9). It sits on bedrock (frequent shaking 3, ground failure 1), far from the volcano (1) and outside the tsunami zone (0). What the total hides: it adds different hazards as if they were interchangeable, so one very severe hazard can be outscored by several moderate ones; it does not show whether a hazard can be engineered for; it ignores what happens if the fault's surface rupture or a landslide blocks the road leading to the bridge; and it treats a 9 for shaking near a fault as no worse than a 9 for liquefaction.

Why: Students should explain the arithmetic and critique the method.

- Explains B's low score using its row scores
- Names one thing the total hides that matters to an engineer

8. A council member says, 'The Ventana Fault has a magnitude 7.5 about every 200 years, and the last one was 170 years ago, so we have about 30 years.' Use what you know about forecasts to respond.

Answer: That is a misreading. 'About every 200 years' is an average from the geologic record; the actual gaps between ruptures vary widely, so the next one could come next year or more than a century from now. The data give a chance (about 40 percent in the next 100 years), not a date. No one can predict when the fault will rupture, so the bridge must be designed for the shaking now, not in 30 years.

Why: Average recurrence intervals are not schedules; this is the forecast-versus-prediction distinction.

- States that an average interval is not a schedule
- Notes the rupture could come much sooner or later
- Concludes the design cannot wait on a date

9. If the county chose Site A, what kinds of monitoring could give warning before a mudflow reaches the bridge? Explain why this kind of warning is possible for a volcano but not for the Ventana Fault.

Answer: Monitoring of Mount Ventana for eruption precursors (seismometers for earthquake swarms, gas sensors, GPS and satellite radar for swelling) would show when an eruption, and so a large mudflow, is becoming more likely, often weeks or months ahead. Sensors along the river channel upstream (detectors for the ground vibration of a passing mudflow, cameras, stream gauges) can detect a mudflow already moving and give minutes of warning to close the bridge. This works for a volcano because magma rising and mudflows travelling downstream take time and make measurable changes; a locked fault gives no reliable warning sign before it slips, so the best possible is a few seconds of early warning once shaking has begun.

Why: Combines precursor monitoring with detection of a moving mudflow; contrasts with the absence of earthquake precursors.

- Names at least one precursor monitoring method
- Mentions detecting a moving mudflow or warning time
- Explains why faults cannot give similar warning

10. Suppose the bridge were an ordinary farm-road bridge instead of the hospital route (no lifeline upgrade, but the site fixes are still needed). Calculate the cost at each site. Would your choice change? Explain.

Answer: Ordinary bridge (basic cost plus site fixes): A $40 + 25 = 65$; B $56 + 4 = 60$; C $80 + 42 = 122$ million dollars. A and B both fit easily and B is still the cheapest, so the choice is likely to stay B. Some groups may argue that for a farm road, where closure is acceptable, Site A's mudflow risk matters less and either A or B is reasonable; C is still over budget.

Why: The importance of the bridge changes the cost and the acceptable damage, which may change how much the residual risk at A matters.

- Costs 65, 60 and 122
- States whether the choice changes, with a reason tied to importance or cost

11. Name two limitations of this decision method or its data, and one extra piece of information you would want before the county spends 90 million dollars.

Answer: Limitations (any two): the data are simulated; the catalog covers only 100 years; chances come from simple averages rather than probability models; the scoring thresholds and the adding of scores are arbitrary choices; intensities are single estimates; costs are invented round numbers. Extra information (any one): drilling and ground surveys at the sites, a probabilistic shaking map for each site, detailed mudflow inundation maps, traffic and detour lengths, environmental effects on the river, or the community's views.

Why: Students should critique both the data and the method.

- Two valid limitations
- One useful extra piece of information

Individual evidence of learning

Each student submits their own scoring table, stacked graph and cost table, and individual answers to q1 through q11. The recommendation (q6) is the main evidence for MS-ESS3-2: it must use frequency or magnitude data to forecast the hazards at each site and connect them to mitigation choices. Questions q8 and q9 check the forecast-versus-prediction distinction; q7 and q11 show evaluation of the method.

Assessment criteria

Criterion	Proficient looks like
Frequency and magnitude analysis	Computes 0.6, 1.7 and 0.7 M5.0+ earthquakes per decade, about 180 times the energy for a 1.5-step difference, and explains equal intensities using distance and ground type.
Systematic scoring	Applies every rule correctly (totals 17, 14 and 28, or consistent with a clearly stated rule interpretation) and identifies the dominant hazard at each site.
Cost and constraints	Computes lifeline totals of 85, 88 and 162 million dollars and identifies which sites fit the budget.
Evidence-based recommendation	Recommends a site with numbers from the scores and costs, explains why the other sites were rejected, and names a remaining hazard.
Forecasting reasoning	Explains that average intervals and percent chances are forecasts, not schedules, and that volcanic hazards can give warning while fault ruptures do not.

Accessibility adaptations

- Pre-fill row 1 of the scoring table for Site A as a worked example, with the rule used written beside each number.
- Provide the scoring rules as a separate large-print card that students can place beside the table.
- Offer a powers ladder for q3 (10 to the 1 = 10; 10 to the 1.5 = about 32; 10 to the 2 = 100; 10 to the 2.25 = about 180).
- Allow the recommendation to be presented orally with the stacked graph as the visual, and recorded for students who need alternative output.

Low-cost alternative

No materials beyond printing are needed. If printing is limited, project the datasets, rules and cost menu and have students copy the scoring and cost tables into notebooks.

Model limitations

This lab has not been physically tested with a class as written; timings are estimates. Ventana County and every number are simulated. Real seismic hazard analysis combines thousands of possible earthquakes, distances and ground types into probabilistic shaking maps, rather than the five-row score used here, and its chances come from probability models, not simple averages. The scoring rules are this lab's own simplification: multiplying and adding scores treats very different hazards as if they could be traded one for one, and the thresholds are arbitrary. A 100-year catalog is short compared with the intervals between the largest earthquakes. Costs are invented round numbers. Real site decisions also weigh traffic, detour length, environmental impacts, land ownership and community input.

Teacher notes

All data and costs are simulated for a fictional county; the scoring rules are this lab's own simplification of hazard analysis. Reference results: frequencies 0.6, 1.7 and 0.7 per decade; scores A 17, B 14, C 28; lifeline costs 85, 88 and 162 million dollars. The intended conclusion is that Site B best meets the criteria and the budget because its dominant hazard is the one a lifeline design is built for, but the strongest learning comes from groups that argue for A and have to deal with the residual mudflow risk. The lifeline targets match slide 24 and Lab 2. The keys for the scoring table, stacked graph and cost table are listed under the ids scoring-table, bar-graph and cost-table.