Runoff Under Pressure

Use test results to evaluate a rain garden and plan its next improvement.

ES.8.b "Use engineering practices to evaluate and refine a current solution designed to protect natural resources from anthropogenic sources of atmospheric, terrestrial, or aquatic pollution."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two design goals, circle the test results that miss a goal, and number one cause and one effect of the heavy-storm problem. Use your marks to decide what the team should test next.

When a Rain Garden Overflows

1. After rain, fertilizer from a school soccer field can wash into a creek. Nitrate in that runoff can fuel algal growth, which may lower oxygen as algae decay. The school installed a rain garden beside the field to protect the creek. A shallow planted basin catches runoff, and soil and plants can remove some nitrate before water leaves.

2. The engineering team set two goals for every tested storm: route at least 70% of field runoff through the garden for treatment and keep nitrate in water leaving the garden at or below 2.0 milligrams per liter (mg/L). They measured nitrate at the inlet and outlet and estimated the fraction of runoff routed through the garden during three storms.

RAIN GARDEN TEST RESULTS

Storm	Inlet nitrate (mg/L)	Outlet nitrate (mg/L)	Runoff routed through garden
Light	4.0	1.0	95%
Moderate	5.0	2.0	75%
Heavy	6.0	4.5	35%

3. In the heavy storm, water spilled around the basin instead of soaking in. The outlet sample represents treated water, not the bypass that also reached the creek. The team proposes widening the garden to catch more flow, but this would take space from the school path. They plan to repeat heavy-storm tests and sample the bypass before deciding.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which storms met both design goals? Use one result for each goal to support your answer.

2. During the heavy storm, how much lower was nitrate at the outlet than at the inlet? Explain why this decrease does not mean the garden met its goals.

3. Why can the outlet sample alone not show the nitrate level of all water reaching the creek during the heavy storm?

4. How might widening the garden address the heavy-storm failure? Name its trade-off and two results the team should check in another heavy storm.

3 YOUR TURN

Your own words

Propose a refinement other than widening the garden. In four or five sentences, explain how it addresses heavy-storm runoff, identify one trade-off, and describe a retest of both project goals.

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PART 1 · READ AND MARK

Underline the two design goals, circle the test results that miss a goal, and number one cause and one effect of the heavy-storm problem. Use your marks to decide what the team should test next. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which storms met both design goals? Use one result for each goal to support your answer.	**The light and moderate storms met both goals. The light storm routed 95% of runoff through the garden and had 1.0 mg/L outlet nitrate; the moderate storm routed 75% and had 2.0 mg/L.**
2	During the heavy storm, how much lower was nitrate at the outlet than at the inlet? Explain why this decrease does not mean the garden met its goals.	**Outlet nitrate was 1.5 mg/L lower. It was still above the 2.0 mg/L limit, and only 35% of runoff went through the garden.**
3	Why can the outlet sample alone not show the nitrate level of all water reaching the creek during the heavy storm?	**Some runoff bypassed the garden and reached the creek. The team did not sample that water, so the outlet sample represents only treated water.**
4	How might widening the garden address the heavy-storm failure? Name its trade-off and two results the team should check in another heavy storm.	**A wider garden could route more runoff through treatment, but it would take space from the school path. The team should check the fraction of runoff routed through the garden and the outlet nitrate level.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would add a storage tank that holds runoff during a heavy storm and releases it slowly into the rain garden. This could send more water through the garden instead of letting it bypass the basin. The tank would cost money and require cleaning. During another heavy storm, I would measure whether at least 70% of runoff passes through the garden and whether outlet nitrate is at or below 2.0 mg/L.

Accept other feasible refinements if students link the change to heavy-storm bypass, identify a trade-off, and test both stated goals. Do not treat the outlet sample as a measurement of bypass water.