AP® Environmental Science
2001 Sample Student Responses

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A.) It is very likely that animal wastes are contaminating the water. Animal wastes are high in Nitrates. Before the boundary of the farm, site A shows a healthy level of nitrates (0.9 ± 0.3 ppm). Immediately after the farm boundary, down stream from site A, Site B showed significantly increased levels of nitrates. The nitrate level was raised to ~~(~~19.3 ± 1.1 ppm~~)~~. This increase shows that some outside factor between point A & point B added nitrates. As the area in between is part of a hog farm it would be quite probable that hog waste was causing the nitrate level increase. Further suggesting this theory, as the students continued farther down the stream, the concentration of nitrates decreased gradually to 12.5 ± 1.0 ppm and then to 6.2 ± 0.5 ppm. This shows that as the water gets further away from the farm it begins to recover from the excess nitrates. This emphasizes that the problem is coming from the area of the farm.

B.) In addition to the students' tests, biological life could be monitored. Each of the sites could be examined for insects and aquatic animals to judge the general healthiness of the environment. They could base these observations on the different taxa levels that determine water quality. Taxa I organisms such as stoneflies and mayflies would suggest very clean water. Taxa II organisms such as crayfish & damselflies would suggest moderately clean water and taxa III only organisms such as pouch snails and leeches would suggest unhealthy water. This test would probably show

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healthy water to moderate water at site A. Site A may contain some organisms from all 3 taxas. However site B would show only organisms from taxa III if any at all due to the poor conditions. Progressing down stream through sites C & D there might be a gradual increase in organisms but no full recovery to the quality shown in site A.

Another test would be for coliform bacteria. This test directly identifies waste from animals and humans by testing for the presence of a bacteria secreted in digestion. Chances are, there would be no coliform present at site A, a large amount of coliform at site B and a gradual decrease of coliform concentration as you continue down the river.

c.) Adding animal waste to an aquatic environment would ultimately be adding nitrates to the water. These nitrates would stimulate algal blooms and dangerous dinoflagellates. This would initially increase the areas DO levels. However, the intense algal blooms will prevent sunlight from reaching aquatic species that dwell below the surface-living algae. The algae will take over and kill out many other organisms. As a result, they will decompose decrease the DO levels while increasing the CO_2 levels in the water. Without consistant DO levels, it is likely that the ecosystem may be entirely wiped out of organisms if the nitrate concentrations are exceptionally high.

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D.) The clean water act is designed to keep water clean. Over the years it has been amended to further protect water and the aquatic species that rely on clean water to survive. The legislation requires that companies must control the amount of toxic waste that enters water. The clean water act monitors industry and punishes them for polluting water.

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(a) It is very likely that animal waste is contaminating the water. At point A the students measured ~~a~~ nitrate at .9 ppm. However, at point B they measured nitrates at 19.3 ppm: a jump of over 20 times. It is almost 100% likely that this jump in ~~%~~ nitrates is due to the dumping of animal waste in the stream. Waste such as fertilizer runoff, manure and liquid waste, and food scraps could contribute to a spike in nitrates in the stream, and these are all waste products likely to be caused by a hog farm.

(b) Two additional test that could be done are ~~Biochemical~~ Biological Oxygen Demand, (BOD) and pH. The BOD test would show ~~that~~ a low BOD at point A, and then a very high BOD at point B. Then BOD would steadily decrease from point B to D. pH concentration would show much the same thing as the pH reading ~~showing a relativity~~ and would be relatively stable.

(c) A Discharge of animal waste ~~could~~ into a stream would result in an increased amount of nutrients in the stream, such as

nitrogen. This would cause an algae bloom at the waste source. This algae would decay and ~~dyer at~~ die ~~from~~ at a magnified rate, increasing BOD and greatly decreasing dissolved O_2. This ~~would~~ lack of oxygen in the stream would probably kill many organisms, especially those with a low tolerance for low O_2 such as Brook trout. For a stretch of the river there would be a dead zone, where very few creatures could survive, until the dissolved oxygen content were to increase back to normal levels.

(d) ~~One~~ One specific provision that could apply to the quality of this stream is the ~~required~~ limited level of nitrates in the water. The stream's nitrate levels are ~~far~~ far too high, and the farmer would have to decrease ~~both~~ runoff ~~and/or dump~~ and eliminate waste dumping to be in compliance with the Clean Water Act. Another provision is the ~~req~~ required amount of dissolved oxygen in the stream. Without oxygen most aquatic life cannot survive, and the stream

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drops below the acceptable level of dissolved oxygen, the farmer would have to take steps to increase dissolved oxygen, such as installing ~~aerating~~ aration fountains or building small waterfalls in the stream.

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(a) Based on the students' data, it is highly likely that animal waste is contaminating the stream water. Immediately after passing through the farm, the stream water shows drastically increased levels of nitrates and phosphates, which are found in animal wastes. Also, sharp increases in Dissolved oxygen (DO) indicate the addition of some kind of organic material to the water.

(b) A fecal coliform test could be used to monitor the number of fecal coliform bacteria in the water. These bacteria feed on nutrients in human and animal waste and their presence would be a good indicator of contamination. Assuming that animal waste from the farm is contaminating the stream, you could expect low levels of fecal coliform bacteria at site A, drastically increased levels at site B, and a gradual reduction in levels from site C to site D as all the waste is consumed and the bacteria die off.

test could be used

Another test you could use to monitor water quality is a turbidity test. This test measures the amount of debris floating in the water. You would expect the turbidity to be low at site A, high at site B after the discharge of wastes into the stream, and then gradually reduced at sites C and D as sediments and debris settle.

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(c) When animal waste is discharged into a stream such as this one, aerobic bacteria that feed on the nutrients in the waste use up lots of oxygen as they feed and grow. Thus DO levels decrease because they're using all the oxygen up. Also levels of nutrients such as phosphates and nitrates go up because these are found in the animal wastes (from when pigs feed on plants grown with fertilizers containing these nutrients.) Addition of phosphates and nitrates may result in eutriphication of the body of water - that is, algal growth will be stimulated by the availability of nutrients, providing more food for small organisms that feed on algae. These organisms use up lots of DO and this may result in the suffocation of other fish when DO levels go down too much.

As the water moves downstream, the "oxygen sag" comes back up because these nutrients get used up, phosphate and nitrate levels go back down, anaerobic bacteria die off, and DO levels return to normal.