

2017

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# AP Environmental Science

## Sample Student Responses and Scoring Commentary

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# AP<sup>®</sup> ENVIRONMENTAL SCIENCE 2017 SCORING GUIDELINES

## Question 1

Read the following article from the *Fremont Daily Times* and answer the questions that follow.

- (a) **Describe** TWO effects that ingesting microbeads has on aquatic organisms.

*(2 points: 1 point for each correct description of an effect of microbeads on aquatic organisms.)*

- Microbeads fill or block the digestive tract
- Organisms accumulate toxic chemicals (PCBs, dioxins) from microbeads, leading to long-term health effects

- (b) Dr. Ewoldsen states that nitrates pose different threats to aquatic ecosystems than microbeads do. **Describe** how nitrate levels can negatively affect water quality in some aquatic ecosystems.

*(2 points: 1 point for a correct description of the ecosystem response to increased nitrate levels and 1 point for a correct description of the effect of increased algal growth on water quality. The effect on water quality must be linked to response to increased nitrate levels to earn point.)*

Response to increased nitrate levels	Effect on water quality
<ul style="list-style-type: none"> <li>• Cause excessive algal growth or algal blooms</li> <li>• Cause cultural eutrophication</li> <li>• Speed eutrophication process</li> </ul>	<ul style="list-style-type: none"> <li>• Algae die and microbes deplete the water of available oxygen (DO) during decomposition of algae (hypoxic/anoxic conditions)</li> <li>• Algal blooms increase turbidity</li> <li>• Algal blooms lead to reduced light penetration</li> <li>• Algal blooms cause taste/odor problems</li> </ul>

- (c) While wastewater treatment plants are ineffective at removing microbeads, they are very effective at removing large pieces of plastic waste and other pollutants.

- (i) **Identify** one way large pieces of plastic are removed from wastewater during primary treatment.

*(1 point for a correct identification of one way plastics are removed during primary treatment.)*

Physical mechanism for removing plastics from the liquid component of wastewater, such as

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Screens/Sieves</li> <li>• Settling</li> <li>• Nets</li> </ul> | <ul style="list-style-type: none"> <li>• Skimmers</li> <li>• Filters</li> <li>• Manual removal</li> </ul> |
|--|---|

- (ii) Prior to discharge, wastewater is often disinfected. **Identify** one technique commonly used to disinfect wastewater.

*(1 point for a correct identification of one technique used to disinfect wastewater.)*

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Chlorination</li> <li>• Treatment with ultraviolet (UV) light</li> </ul> | <ul style="list-style-type: none"> <li>• Ozonation</li> <li>• Membrane filtration (reverse osmosis and ultrafiltration)</li> </ul> |
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**Question 1 (continued)**

- (iii) Sludge or biosolids produced during the wastewater treatment process can be spread on agricultural fields. **Identify** one advantage and one disadvantage of this practice.

*(2 points: 1 point for a correct identification of an advantage of spreading sludge and 1 point for a correct identification of a disadvantage of spreading sludge.)*

<b>Advantage</b>	<b>Disadvantage</b>
<ul style="list-style-type: none"> <li>• Used as fertilizer</li> <li>• Increases crop yields/crop revenue</li> <li>• Improves soil quality</li> <li>• Reduces need for disposal of sludge/biosolids in landfills or by incineration</li> <li>• Generates revenue from sale of sludge/biosolids</li> <li>• May be less expensive than commercial fertilizer</li> <li>• May be least expensive disposal option</li> </ul>	<ul style="list-style-type: none"> <li>• Foul odors</li> <li>• Surface water and groundwater contamination by nutrients, heavy metals, pharmaceuticals, hormones, pathogens</li> <li>• Soil contamination by heavy metals, pharmaceuticals, hormones, pathogens</li> <li>• Crop contamination by heavy metals, pharmaceuticals, pathogens</li> <li>• Lack of public acceptance</li> </ul>

- (d) Coastal ecosystems are threatened by other human activities in addition to wastewater disposal. Mangrove swamps are one such threatened ecosystem.

- (i) **Provide** one reason why mangrove trees are being removed by humans.

*(1 point for a correct reason for why mangrove trees are being removed by humans.)*

- Establishing aquaculture facilities (fish and shrimp farming)
- Expanding agriculture
- Developing coastal areas (e.g., marinas, condos, resorts, infrastructure)
- Harvesting mangroves for wood products, including paper pulp
- Burning mangroves for energy/charcoal production
- Removing mangroves for aesthetic reasons (to improve views)
- Removing trees to increase access to coastal waters

- (ii) **Identify** one ecosystem service provided by intact mangrove ecosystems.

*(1 point for a correct identification of an ecosystem service provided by intact mangroves.)*

- Shoreline stabilization/protection (e.g., storm surge, tsunami, wave action)
- Commercial fisheries
- Nursery grounds for aquatic organisms
- Biodiversity preservation
- Flood control
- Groundwater recharge
- Sediment/nutrient retention
- Nutrient cycling
- Absorption of carbon dioxide and release of oxygen
- Purification of water, air
- Ecotourism/tourism/recreational opportunities
- Protection from saltwater intrusion

- 1.a. Ingesting microbeads can block the digestive tracts of fish, which prevents food from being digested and can kill fish due to starvation. Another effect ~~is~~ is bioaccumulation of toxins such as DDT. Since the ~~spine~~ microbeads can absorb organic pollutants such as DDT and dioxin, if fish eat them, they will contain the toxin, and as organisms consume fish up the food chain, the toxins will bioaccumulate especially in the tissues of predators near the top of the food chain—and they may die, as well.
- 1.b. The addition of nitrates to aquatic ecosystems often leads to eutrophication. When nitrate levels are high, more algae can bloom because nitrogen is a limiting factor. When the surplus of algae dies, oxygen is extracted from the water ~~so~~ so decomposition may occur. This dramatically reduces D.O. (or dissolved oxygen) levels, which can cause organisms to suffocate and die.
- 1.c.i. Large pieces of plastic are removed from wastewater by tools named bar screens.
- 1.c.ii. ~~Chlorine~~ Chlorination is often used to disinfect wastewater. The addition of chlorine to water kills harmful bacteria and microorganisms, and therefore disinfects water.
- 1.c.iii. One advantage of the usage of biosolids on agriculture

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

ral fields is the use of waste as fertilizer. The fertilizer is natural and supports plant growth, which puts a waste product to use in a beneficial way. ~~the~~ A drawback to this process is the possibility of eutrophication. Runoff from agricultural fields that use biosolids as fertilizer often contain amounts of biosolids that naturally contain elements such as nitrogen and phosphorus, which, when introduced to an aquatic system, can promote eutrophication and the suffocation of many organisms.

1.d.i. Mangrove trees are removed by humans in order for humans to build on mangrove swamps. When humans want to ~~be~~ have buildings on mangrove swamps, they remove the trees to make room.

1.d.ii. Intact mangrove ecosystems ~~are key~~ buffer ~~zones~~ filter water. They have been recognized for their ability to remove unwanted items from water and filter the freshwater.

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## PAGE FOR ANSWERING QUESTION 1

- A). Microbeads can't be digested ~~and~~ and they fill up the organisms ~~blow~~ stomach which eventually ~~leads~~ leads to starvation. Microbeads contaminated with PCBs ~~can make~~ that organisms eat cause the pollution to have a worse impact on said organism.
- B). High nitrate levels allow for algae to flourish and form a layer that blocks out sunlight, lowering the amount of sunlight in the water negatively impacting organisms like coral that rely on that sunlight to stay alive.
- Ci) Metal grates block large pieces of plastic from moving further into the sewage treatment ~~fast~~ process.
- Cii) Chlorine is added to the water in order to disinfect water.
- Ciii) An advantage is that less synthetic fertilizers have to be used. A disadvantage is run off can bring that sludge back into the water system that it was just taken out of.
- Di) Humans want to build a dock where the mangroves are so they remove them.
- Dii) Intact mangroves ~~is~~ keep the soil in place and prevent ~~erosion~~ soil erosion from occurring.

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## PAGE FOR ANSWERING QUESTION 1

a) Microbeads can impact aquatic organisms through ingestion. The intake of microbeads can cause blockages in the digestive tracts of aquatic organisms. Microbeads can also absorb pollutants like ~~PEB's~~ PCBs that can enter the bodies of aquatic organisms through ingestion.

b) While nitrates and microbeads can both harm aquatic ecosystems and negatively affect water quality, consequences from nitrates are different. High nitrate levels can be considered nutrient pollution. Nutrient pollution results in overblooms of algae, eutrophication, and eventually results in hypoxic zones.

c) i) Large pieces of plastic can be removed from wastewater during primary treatment, by use of filters.

ii) One technique that is commonly used to disinfect wastewater, is the process of boiling.

iii) One advantage of using sludge or biosolids on agricultural fields is that it provides organic fertilizer. One disadvantage of ~~the~~ the use of this practice, ~~is~~ is that, runoff from these fields could return to the water supply.

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

d) i) Humans are cutting down mangrove trees in an attempt to develop the land on which they are growing.

ii) ~~One~~ One ecosystem service provided by intact mangroves, is the natural filtration of water.

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## Question 1

### Overview

This question was intended to have students describe the impact of various pollutants on aquatic organisms and on water quality, to identify and describe common methods of sewage (wastewater) treatment, and to demonstrate an understanding of the importance of mangrove swamps, an example of an ecosystem threatened by human activities. Students were asked to read the document provided and describe the impacts of ingesting microbeads on aquatic organisms. This concept was drawn from VI. Pollution, B. Impacts on the Environment and Human Health, 2. Hazardous Chemicals in the Environment of the topic outline. Students were then asked to describe how nitrates, a different water pollutant, can negatively affect water quality in some aquatic ecosystems.

The next part of the question evaluated student understanding of wastewater treatment. Students were asked to identify one way large objects, such as plastic, could be removed during primary wastewater treatment and to then identify one common technique to disinfect wastewater prior to discharge. Additionally, students were asked to identify one advantage and one disadvantage of spreading biosolids (sludge) on agricultural fields. These concepts were drawn from VI. Pollution, subtopic A. Pollution Types, section 3. Water Pollution of the topic outline.

Students were then asked to demonstrate their knowledge of the importance of ecosystem diversity and the threat of human activities to ecosystems using the mangrove forest as an example of a threatened coastal ecosystem. Students were asked to provide a reason as to why humans remove mangrove trees and to identify an ecosystem service provided by intact mangrove forests. These concepts were drawn from II. The Living World, subtopic C. Ecosystem Diversity of the topic outline.

### Sample: 1A

#### Score: 10

The student earned 2 points in part (a): 1 point for describing that microbeads “can block the digestive tracts of fish” and 1 point for describing the “bioaccumulation of toxins such as DDT” as a second effect of ingesting microbeads. The student earned 2 points in part (b): 1 point for describing that “when nitrate levels are high, more algae can bloom” and 1 point for describing how when algae dies, “decomposition may occur. This dramatically reduces D.O. (or dissolved oxygen) levels.” This response demonstrates the link between algal blooms and the negative effect on water quality, reduced levels of dissolved oxygen. The student earned 1 point in (c)(i) for stating “bar screens” as a method to remove large pieces of plastic from wastewater during primary treatment. The student earned 1 point in (c)(ii) for identifying that “chlorination is often used to disinfect wastewater.” The response earned 2 points in (c)(iii): 1 point for identifying “the use of waste as fertilizer” as one advantage to spreading biosolids on agricultural fields and 1 point for identifying that biosolids “naturally contain elements, such as nitrogen and phosphorus, which, when introduced to an aquatic system, can promote eutrophication.” The response clearly identifies how specific chemicals in the biosolids runoff can contaminate surface water as the disadvantage. The response earned 1 point in (d)(i) for identifying “Mangrove trees are removed by humans in order for humans to build on mangrove swamps.” The response earned 1 point in (d)(ii) for identifying that “intact mangrove ecosystems filter water” as an ecosystem service.

### Sample: 1B

#### Score: 8

The student earned 1 point in part (a) for describing that microbeads “fill up the organisms [sic] stomach.” No additional point was earned because PCBs are not described as toxic chemicals that impact the long-term health of aquatic organisms. The response earned 2 points in part (b): 1 point for describing how

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### Question 1 (continued)

high nitrate levels “allow for algae to flourish” as a description of an algal bloom and 1 point for describing that the algae “form a layer that blocks out sunlight” negatively impacting water quality. The student earned 1 point in (c)(i) for identifying that “metal grates block large pieces of plastic from moving further into the sewage treatment process.” The student earned 1 point in (c)(ii) for identifying chlorine as a disinfectant. The student earned 1 point was earned in (c)(iii) for identifying one advantage of using biosolids as “less synthetic fertilizers have to be used.” No additional point was earned for the disadvantage given because a specific pollutant is not identified in the runoff. The student earned 1 point in (d)(i) for identifying coastal development, by stating that mangroves may be removed “to build a dock.” The response earned 1 point in (d)(ii) for identifying the ecosystem service of sediment retention because “Intact mangroves keep the soil in place and prevent soil erosion.”

#### **Sample: 1C**

#### **Score: 6**

The student earned 1 point in part (a) for describing that microbeads “can cause blockages in the digestive tracts of aquatic organisms.” No additional point was earned because PCBs are not described as toxic chemicals that impact long-term health. The student earned 1 point in part (b) for describing an algal bloom. No additional point was earned because the response does not include the intermediate step of decomposition leading to hypoxic zones. The student earned 1 point in (c)(i) for identifying the use of filters as a method to remove large pieces of plastic. The student earned 1 point in (c)(iii) for identifying that biosolids “provides organic fertilizer” as an advantage. No additional point was earned for identifying a disadvantage because a specific compound in the runoff is not identified. The student earned 1 point in (d)(i) for identifying that mangrove trees are removed by humans “in an attempt to develop the land.” The student earned 1 point in (d)(ii) for identifying “the natural filtration of water” as an ecosystem service provided by mangroves.