ENVIRONMENTAL SCIENCE
SECTION II
Time—90 minutes
4 Questions

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in the pink booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. Read the *Fremont Examiner* article below and answer the questions that follow.

10 FREMONT EXAMINER May 15, 2007

CITY COUNCIL SEWAGE VOTE

Last night the Fremont City Council, by a 4-to-1 vote, approved an upgrade of the town's sewage treatment facility. The treatment plant, which currently discharges one million gallons of treated wastewater into the Fremont River daily, will be upgraded from primary to secondary treatment next year. Councilperson Ramos noted that the upgrade was needed to protect the water quality of the Fremont River. A local environmental scientist, Dr. Goodwin, advised the council members that sewage treatment plants may solve a water quality problem, but they create a solid-waste problem.

(a) Identify ONE component of the sewage that is targeted for removal by primary treatment and ONE component of the sewage that is targeted for removal by secondary treatment.

(b) For EACH of the pollutants that you identified in part (a), describe how the pollutant is removed in the treatment process.

(c) Explain how sewage treatment plants create the solid waste problem that Dr. Goodwin mentioned in the article.

(d) Two common methods of disposing of solid waste from sewage treatment plants are transporting it to a landfill or spreading it onto agricultural lands. Describe an environmental problem associated with EACH of these methods.

(e) The final step in sewage treatment is disinfection. Identify ONE pollutant that is targeted during disinfection and identify ONE commonly used method of disinfection.

(f) Identify ONE United States federal law that requires monitoring the quality of the treated sewage that is discharged into the Fremont River.

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Question 1

Read the Fremont Examiner article below and answer the questions that follow.

(a) Identify ONE component of the sewage that is targeted for removal by primary treatment and ONE component of the sewage that is targeted for removal by secondary treatment. (2 points—1 point for each)

Primary treatment removal	Secondary treatment removal
Any relatively large (macroscopic) solid material (e.g. rocks, gravel, sand, solid human or animal waste, twigs, cans, etc)	Dissolved/suspended organic materials such as human waste products, soaps, detergents, food waste, pathogens (e.g., *E. coli*)
Fats, oil, or grease (FOG)	Phosphates, Nitrates

(b) For EACH of the pollutants that you identified in part (a), describe how the pollutant is removed in the treatment process. (2 points—1 point for each)

PRIMARY TREATMENT

Pollutant	Removal mechanism
All large objects such as rags, sticks, condoms, cans, tampons, fruit, etc.	Description of a physical process for removing solids from the liquid component (grid filtration, screening, sieving, nets, filters, etc.)
Sand, grit, fecal material	A settling tank; incoming wastewater is slowed so sand, grit, small rocks, fecal material can settle out (also called a detritor or sand catcher)
Fats, oil, or grease	Allowed to float to the top of the wastewater, where it can be mechanically skimmed off

SECONDARY TREATMENT

Pollutant	Removal mechanism
Any dissolved/suspended organic substance	1) Effluent is brought in contact with oxygen and aerobic microorganisms that break down/consume the organic matter 2) Anaerobic microbial digester 3) Secondary sedimentation and floc removal
Pathogens (bacteria, *E. coli*, etc.)	Disinfection (chlorine, ozone, UV, etc.)
Phosphate	Lime, alum, aluminum sulfate, iron chloride, iron sulfate, biological removal
Nitrates/Ammonia	Denitrifying bacteria (anaerobic microbial digester)

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Question 1 (continued)

(c) Explain how sewage treatment plants create the solid waste problem that Dr. Goodwin mentioned in the article. (1 point)

Particulates and other substances removed from wastewater during primary and secondary treatment create a significant amount of solid material which must then be disposed of elsewhere.

(d) Two common methods of disposing of solid waste from sewage treatment plants are transporting it to a landfill or spreading it onto agricultural lands. Describe an environmental problem associated with EACH of these methods. (2 points)

Landfill Problems	Agricultural Problems
Takes up a considerable amount of landfill space (resulting in expansion or new development of landfills) Potential groundwater contamination (toxins, contaminants, heavy metals, leachates) Greenhouse gases, such as methane, produced during anaerobic decomposition can escape into the atmosphere and contribute to global warming Environmental effects associated with transportation of solid waste	Human/animal health problems associated with bacterial wastes contaminating food/feed crops Potential groundwater/soil/plant contamination (toxins, contaminants, heavy metals, leachates) Incorporation of toxins/heavy metals into the food chain Field runoff resulting in surface water contamination (eutrophication/oxygen depletion of surface waters due to wastes high in nitrogen or phosphorus)

(e) The final step in sewage treatment is disinfection. Identify ONE pollutant that is targeted during disinfection and identify ONE commonly used method of disinfection. (2 points—1 point for identifying a pollutant and 1 point for identifying a method of disinfection)

Pollutants: Pathogenic contaminants:

- *E. coli* bacteria
- Coliform bacteria
- *Giardia*
- Pathogens
- Microorganisms/bacteria
- Cholera
- Viruses

Question 1 (continued)

Method of disinfection (pollutant and disinfection method do NOT need to be linked)**:**

- chlorine or ozone (or other oxidizing chemicals such as bromine, iodine or hydrogen peroxide, bleach/sodium hypochlorite, chloramines)
- ultraviolet radiation (UV)
- microfiltration (using ceramic filters)
- lime treatment
- electron beam radiation

(f) Identify ONE United States federal law that requires monitoring the quality of the treated sewage that is discharged into the Fremont River. (1 point for specifically identifying a U.S. federal law)

- (Federal) Water and Pollution Control Act (1956)
- National Environmental Policy Act (1969)
- (Federal) Water Pollution Control Act (1972), (1977), (1987)—"Clean Water Act" accepted
- (Federal) Safe Drinking Water Act (1974)—amended in 1996 to include protection of drinking water sources