

## AP ENVIRONMENTAL SCIENCE

# UNIT 8

# Aquatic and Terrestrial Pollution



**7–10%**

AP EXAM WEIGHTING



**~19–20**

CLASS PERIODS

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# Aquatic and Terrestrial Pollution



## Developing Understanding

### BIG IDEA 3

#### *Interactions Between Different Species and the Environment* **EIN**

- How does pollution impact your health?

### BIG IDEA 4

#### *Sustainability* **STB**

- How can you decrease your waste?

Pollution created by human activities directly impacts ecosystems in the air, on land, and in water. The source of pollution can sometimes be easy to identify, but other times the source is diffused. There are many human health issues that can be linked to pollution. Legislation has been created to reduce discharges of pollution in water and regulate drinking water. Increases in waste cause global concerns for organisms that live on land and in water. In the final unit, students will explore how local and regional human activities can have a global impact.

## Building the Science Practices

**2.A 2.B 2.C 6.A 6.B**

Students should be able to think critically about an environmental problem and evaluate a given solution, articulating the benefits and drawbacks. Students should also be able to propose their own solutions to environmental problems. In order to understand the implications of environmental legislation, students need to see how policies are applied in different contexts. They also need to see the outcomes of those policies in context to fully address an environmental problem. Students should then be able to explain why those outcomes occurred and how the policy affected the outcomes.

Quantitative skills are also important in this unit and can be addressed by having students perform water quality or dissolved oxygen labs. This will give them the opportunity to perform calculations with their data. These lab experiences will also provide students contexts to evaluate environmental problems.

## Preparing for the AP Exam

On the AP Exam, students must be able to explain concepts related to the different types of pollution that impact land and water. Students often struggle with evaluating data related to pollution. To combat this, teachers can practice through hands-on laboratory activities related to pollution. Students can then discuss their observations and data. They may also benefit from multiple opportunities to analyze data by describing the relationships among the variables. They can explain the meaning of the data and the implications the data illustrate about pollution.

Students often struggle if problems on the AP Exam require multiple steps to obtain an answer. Teachers can provide students with practice solving problems related to pollution using appropriate methods to calculate numerical answers, with appropriate units. As students practice calculations, it is often helpful to emphasize a logical step-by-step method that shows how their problem solving ends with a numerical answer and appropriate units.

## TOPIC 8.1

# Sources of Pollution

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.A**

Identify differences between point and nonpoint sources of pollution.

### ESSENTIAL KNOWLEDGE

**STB-3.A.1**

A point source refers to a single, identifiable source of a pollutant, such as a smokestack or waste discharge pipe.

**STB-3.A.2**

Nonpoint sources of pollution are diffused and can therefore be difficult to identify, such as pesticide spraying or urban runoff.

**SUGGESTED SKILL**

 *Concept Explanation*

**1.A**

Describe environmental concepts and processes.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)

**SUGGESTED SKILL**

 **Mathematical Routines**

**6.B**

Apply appropriate mathematical relationships to solve a problem, with work shown (e.g., dimensional analysis).



**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- The Exam > [Student Performance Q&A 2015, Q3](#)
- The Exam > [Samples and Commentary 2015, Q3](#)

**TOPIC 8.2**

# Human Impacts on Ecosystems

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.B**

Describe the impacts of human activities on aquatic ecosystems.

### ESSENTIAL KNOWLEDGE

**STB-3.B.1**

Organisms have a range of tolerance for various pollutants. Organisms have an optimum range for each factor where they can maintain homeostasis. Outside of this range, organisms may experience physiological stress, limited growth, reduced reproduction, and in extreme cases, death.

**STB-3.B.2**

Coral reefs have been suffering damage due to a variety of factors, including increasing ocean temperature, sediment runoff, and destructive fishing practices.

**STB-3.B.3**

Oil spills in marine waters cause organisms to die from the hydrocarbons in oil. Oil that floats on the surface of water can coat the feathers of birds and fur of marine mammals. Some components of oil sink to the ocean floor, killing some bottom-dwelling organisms.

**STB-3.B.4**

Oil that washes up on the beach can have economic consequences on the fishing and tourism industries.

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## LEARNING OBJECTIVE

### STB-3.B

Describe the impacts of human activities on aquatic ecosystems.

## ESSENTIAL KNOWLEDGE

### STB-3.B.5

Oceanic dead zones are areas of low oxygen in the world's oceans caused by increased nutrient pollution.

### STB-3.B.6

An oxygen sag curve is a plot of dissolved oxygen levels versus the distance from a source of pollution, usually excess nutrients and biological refuse.

### STB-3.B.7

Heavy metals used for industry, especially mining and burning of fossil fuels, can reach the groundwater, impacting the drinking water supply.

### STB-3.B.8

Litter that reaches aquatic ecosystems, besides being unsightly, can create intestinal blockage and choking hazards for wildlife and introduce toxic substances to the food chain.

### STB-3.B.9

Increased sediment in waterways can reduce light infiltration, which can affect primary producers and visual predators. Sediment can also settle, disrupting habitats.

### STB-3.B.10

When elemental sources of mercury enter aquatic environments, bacteria in the water convert it to highly toxic methylmercury.

**SUGGESTED SKILL**

 *Concept Explanation*

**1.A**

Describe environmental concepts and processes.



**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)

**TOPIC 8.3**

# Endocrine Disruptors

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.C**

Describe endocrine disruptors.

**STB-3.D**

Describe the effects of endocrine disruptors on ecosystems.

### ESSENTIAL KNOWLEDGE

**STB-3.C.1**

Endocrine disruptors are chemicals that can interfere with the endocrine system of animals.

**STB-3.D.1**

Endocrine disruptors can lead to birth defects, developmental disorders, and gender imbalances in fish and other species.

## TOPIC 8.4

# Human Impacts on Wetlands and Mangroves

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.E**

Describe the impacts of human activity on wetlands and mangroves.

### ESSENTIAL KNOWLEDGE

**STB-3.E.1**

Wetlands are areas where water covers the soil, either part or all of the time.


**STB-3.E.2**

Wetlands provide a variety of ecological services, including water purification, flood protection, water filtration, and habitat.

**STB-3.E.3**

Threats to wetlands and mangroves include commercial development, dam construction, overfishing, and pollutants from agriculture and industrial waste.

**SUGGESTED SKILL**

 *Environmental Solutions*


**7.B**

Describe potential responses or approaches to environmental problems.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > [Student Performance Q&A 2015, Q1](#)
- The Exam > [Samples and Commentary 2015, Q1](#)

## SUGGESTED SKILL

 *Visual Representations*

## 2.C

Explain how environmental concepts and processes represented visually relate to broader environmental issues.



## AVAILABLE RESOURCES

- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)

## TOPIC 8.5

# Eutrophication

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.F**

Explain the environmental effects of excessive use of fertilizers and detergents on aquatic ecosystems.

### ESSENTIAL KNOWLEDGE

**STB-3.F.1**

Eutrophication occurs when a body of water is enriched in nutrients.

**STB-3.F.2**

The increase in nutrients in eutrophic aquatic environments causes an algal bloom. When the algal bloom dies, microbes digest the algae, along with the oxygen in the water, leading to a decrease in the dissolved oxygen levels in the water. The lack of dissolved oxygen can result in large die-offs of fish and other aquatic organisms.

**STB-3.F.3**

Hypoxic waterways are those bodies of water that are low in dissolved oxygen.

**STB-3.F.4**

Compared to eutrophic waterways, oligotrophic waterways have very low amounts of nutrients, stable algae populations, and high dissolved oxygen.

**STB-3.F.5**

Anthropogenic causes of eutrophication are agricultural runoff and wastewater release.



## TOPIC 8.6

# Thermal Pollution

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.G**

Describe the effects of thermal pollution on aquatic ecosystems.

### ESSENTIAL KNOWLEDGE

**STB-3.G.1**

Thermal pollution occurs when heat released into the water produces negative effects to the organisms in that ecosystem.

**STB-3.G.2**

Variations in water temperature affect the concentration of dissolved oxygen because warm water does not contain as much oxygen as cold water.

**SUGGESTED SKILL**

 *Concept Explanation*

**1.C**

Explain environmental concepts, processes, or models in applied contexts.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)

## SUGGESTED SKILL

 *Concept Explanation***1.B**

Explain environmental concepts and processes.



## AVAILABLE RESOURCES

- Classroom Resource >  
[AP Environmental Science Teacher's Guide](#)

## TOPIC 8.7

# Persistent Organic Pollutants (POPs)

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.H**

Describe the effect of persistent organic pollutants (POPs) on ecosystems.

### ESSENTIAL KNOWLEDGE

**STB-3.H.1**

Persistent organic pollutants (POPs) do not easily break down in the environment because they are synthetic, carbon-based molecules (such as DDT and PCBs).

**STB-3.H.2**

Persistent organic pollutants (POPs) can be toxic to organisms because they are soluble in fat, which allows them to accumulate in organisms' fatty tissues.

**STB-3.H.3**

Persistent organic pollutants (POPs) can travel over long distances via wind and water before being redeposited.

## TOPIC 8.8

# Bioaccumulation and Biomagnification

### SUGGESTED SKILL

 *Scientific Experiments*

#### 4.A

Identify a testable hypothesis or scientific question for an investigation.



### AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > Chief Reader Report (2018, Q3, 2017, Q1)
- The Exam > Samples and Commentary (2018, Q3, 2017, Q1)

## Required Course Content

### ENDURING UNDERSTANDING

#### STB-3

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

#### STB-3.I

Describe bioaccumulation and biomagnification.

#### STB-3.J

Describe the effects of bioaccumulation and biomagnification.

### ESSENTIAL KNOWLEDGE

#### STB-3.I.1

Bioaccumulation is the selective absorption and concentration of elements or compounds by cells in a living organism, most commonly fat-soluble compounds.

#### STB-3.I.2

Biomagnification is the increase in concentration of substances per unit of body tissue that occurs in successively higher trophic levels of a food chain or in a food web.

#### STB-3.J.1

Some effects that can occur in an ecosystem when a persistent substance is biomagnified in a food chain include eggshell thinning and developmental deformities in top carnivores of the higher trophic levels.


#### STB-3.J.2

Humans also experience harmful effects from biomagnification, including issues with the reproductive, nervous, and circulatory systems.

#### STB-3.J.3

DDT, mercury, and PCBs are substances that bioaccumulate and have significant environmental impacts.

**SUGGESTED SKILL**

 *Environmental Solutions*

**7.D**

Use data and evidence to support a potential solution.



**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > Chief Reader Report (2018, Q3, 2017, Q1)
- The Exam > Samples and Commentary (2018, Q3, 2017, Q1)

**TOPIC 8.9**

# Solid Waste Disposal

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.K**

Describe solid waste disposal methods.

### ESSENTIAL KNOWLEDGE

**STB-3.K.1**

Solid waste is any discarded material that is not a liquid or gas. It is generated in domestic, industrial, business, and agricultural sectors.

**STB-3.K.2**

Solid waste is most often disposed of in landfills. Landfills can contaminate groundwater and release harmful gases.

**STB-3.K.3**

Electronic waste, or e-waste, is composed of discarded electronic devices including televisions, cell phones, and computers.

**STB-3.K.4**

A sanitary municipal landfill consists of a bottom liner (plastic or clay), a storm water collection system, a leachate collection system, a cap, and a methane collection system.

**STB-3.L**

Describe the effects of solid waste disposal methods.

**STB-3.L.1**

Factors in landfill decomposition include the composition of the trash and conditions needed for microbial decomposition of the waste.

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## LEARNING OBJECTIVE

### STB-3.L

Describe the effects of solid waste disposal methods.

## ESSENTIAL KNOWLEDGE

### STB-3.L.2

Solid waste can also be disposed of through incineration, where waste is burned at high temperatures. This method significantly reduces the volume of solid waste but releases air pollutants.

### STB-3.L.3

Some items are not accepted in sanitary landfills and may be disposed of illegally, leading to environmental problems. One example is used rubber tires, which when left in piles can become breeding grounds for mosquitoes that can spread disease.

### STB-3.L.4

Some countries dispose of their waste by dumping it in the ocean. This practice, along with other sources of plastic, has led to large floating islands of trash in the oceans. Additionally, wildlife can become entangled in the waste, as well as ingest it.

## SUGGESTED SKILL

 Mathematical Routines

## 6.B

Apply appropriate mathematical relationships to solve a problem, with work shown (e.g., dimensional analysis).



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > Chief Reader Report (2018, Q3, 2017, Q1)
- The Exam > Samples and Commentary (2018, Q3, 2017, Q1)

## TOPIC 8.10

# Waste Reduction Methods

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.M**

Describe changes to current practices that could reduce the amount of generated waste and their associated benefits and drawbacks.

### ESSENTIAL KNOWLEDGE

**STB-3.M.1**

Recycling is a process by which certain solid waste materials are processed and converted into new products.

**STB-3.M.2**

Recycling is one way to reduce the current global demand on minerals, but this process is energy-intensive and can be costly.

**STB-3.M.3**

Composting is the process of organic matter such as food scraps, paper, and yard waste decomposing. The product of this decomposition can be used as fertilizer. Drawbacks to composting include odor and rodents.

**STB-3.M.4**

E-waste can be reduced by recycling and reuse. E-wastes may contain hazardous chemicals, including heavy metals such as lead and mercury, which can leach from landfills into groundwater if they are not disposed of properly.

**STB-3.M.5**

Landfill mitigation strategies range from burning waste for energy to restoring habitat on former landfills for use as parks.

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### LEARNING OBJECTIVE

**STB-3.M**


Describe changes to current practices that could reduce the amount of generated waste and their associated benefits and drawbacks.

### ESSENTIAL KNOWLEDGE

**STB-3.M.6**

The combustion of gases produced from decomposition of organic material in landfills can be used to turn turbines and generate electricity. This process reduces landfill volume.

## SUGGESTED SKILL

 *Visual Representations*

## 2.A

Describe characteristics of an environmental concept, process, or model represented visually.



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > [Chief Reader Report 2017, Q1](#)
- The Exam > [Student Performance Q&A 2014, Q2](#)
- The Exam > [Samples and Commentary \(2017, Q1, 2014, Q2\)](#)

## TOPIC 8.11

# Sewage Treatment

## Required Course Content

### ENDURING UNDERSTANDING

**STB-3**

Human activities, including the use of resources, have physical, chemical, and biological consequences for ecosystems.

### LEARNING OBJECTIVE

**STB-3.N**

Describe best practices in sewage treatment.

### ESSENTIAL KNOWLEDGE

**STB-3.N.1**

Primary treatment of sewage is the physical removal of large objects, often through the use of screens and grates, followed by the settling of solid waste in the bottom of a tank.

**STB-3.N.2**

Secondary treatment is a biological process in which bacteria break down organic matter into carbon dioxide and inorganic sludge, which settles in the bottom of a tank. The tank is aerated to increase the rate at which the bacteria break down the organic matter.

**STB-3.N.3**

Tertiary treatment is the use of ecological or chemical processes to remove any pollutants left in the water after primary and secondary treatment.

**STB-3.N.4**

Prior to discharge, the treated water is exposed to one or more disinfectants (usually, chlorine, ozone, or UV light) to kill bacteria.



## TOPIC 8.12

# Lethal Dose 50% ( $LD_{50}$ )

## Required Course Content

### ENDURING UNDERSTANDING

**EIN-3**

Pollutants can have both direct and indirect impacts on the health of organisms, including humans.

### LEARNING OBJECTIVE

**EIN-3.A**

Define lethal dose 50% ( $LD_{50}$ ).

### ESSENTIAL KNOWLEDGE

**EIN-3.A.1**

Lethal dose 50% ( $LD_{50}$ ) is the dose of a chemical that is lethal to 50% of the population of a particular species.

**SUGGESTED SKILL**

 *Mathematical Routines*

**6.A**

Determine an approach or method aligned with the problem to be solved.

**AVAILABLE RESOURCES**

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)

## SUGGESTED SKILL

 Data Analysis

## 5.E

Explain what the data implies or illustrates about environmental issues.



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)

## TOPIC 8.13

# Dose Response Curve

## Required Course Content

### ENDURING UNDERSTANDING

**EIN-3**

Pollutants can have both direct and indirect impacts on the health of organisms, including humans.

### LEARNING OBJECTIVE

**EIN-3.B**

Evaluate dose response curves.

### ESSENTIAL KNOWLEDGE

**EIN-3.B.1**

A dose response curve describes the effect on an organism or mortality rate in a population based on the dose of a particular toxin or drug.

## TOPIC 8.14

# Pollution and Human Health

## SUGGESTED SKILL

 *Scientific Experiments***4.C**

Describe an aspect of a research method, design, and/or measure used.



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)
- External Resource > [Environmental Literacy Council's AP Environmental Science Course Material](#)
- The Exam > Chief Reader Report (**2018, Q4, 2017, Q1**)
- The Exam > Samples and Commentary (**2018, Q4, 2017, Q1**)

## Required Course Content

### ENDURING UNDERSTANDING

**EIN-3**

Pollutants can have both direct and indirect impacts on the health of organisms, including humans.

### LEARNING OBJECTIVE

**EIN-3.C**

Identify sources of human health issues that are linked to pollution.

### ESSENTIAL KNOWLEDGE

**EIN-3.C.1**

It can be difficult to establish a cause and effect between pollutants and human health issues because humans experience exposure to a variety of chemicals and pollutants.

**EIN-3.C.2**

Dysentery is caused by untreated sewage in streams and rivers.


**EIN-3.C.3**

Mesothelioma is a type of cancer caused mainly by exposure to asbestos.

**EIN-3.C.4**

Respiratory problems and overall lung function can be impacted by elevated levels of tropospheric ozone.

## SUGGESTED SKILL

 *Visual Representations*

## 2.B

Explain relationships between different characteristics of environmental concepts, processes, or models represented visually:

- In theoretical contexts
- In applied contexts



## AVAILABLE RESOURCES

- Classroom Resource > [AP Environmental Science Teacher's Guide](#)

## TOPIC 8.15

# Pathogens and Infectious Diseases

## Required Course Content

### ENDURING UNDERSTANDING

**EIN-3**

Pollutants can have both direct and indirect impacts on the health of organisms, including humans.

### LEARNING OBJECTIVE

**EIN-3.D**

Explain human pathogens and their cycling through the environment.

### ESSENTIAL KNOWLEDGE

**EIN-3.D.1**

Pathogens adapt to take advantage of new opportunities to infect and spread through human populations.

**EIN-3.D.2**

Specific pathogens can occur in many environments regardless of the appearance of sanitary conditions.

**EIN-3.D.3**

As equatorial-type climate zones spread north and south in to what are currently subtropical and temperate climate zones, pathogens, infectious diseases, and any associated vectors are spreading into these areas where the disease has not previously been known to occur.

**EIN-3.D.4**

Poverty-stricken, low-income areas often lack sanitary waste disposal and have contaminated drinking water supplies, leading to havens and opportunities for the spread of infectious diseases.

**EIN-3.D.5**

Plague is a disease carried by organisms infected with the plague bacteria. It is transferred to humans via the bite of an infected organism or through contact with contaminated fluids or tissues.

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## LEARNING OBJECTIVE

### EIN-3.D

Explain human pathogens and their cycling through the environment.

## ESSENTIAL KNOWLEDGE

### EIN-3.D.6

Tuberculosis is a bacterial infection that typically attacks the lungs. It is spread by breathing in the bacteria from the bodily fluids of an infected person.

### EIN-3.D.7

Malaria is a parasitic disease caused by bites from infected mosquitoes. It is most often found in sub-Saharan Africa.

### EIN-3.D.8

West Nile virus is transmitted to humans via bites from infected mosquitoes.

### EIN-3.D.9

Severe acute respiratory syndrome (SARS) is a form of pneumonia. It is transferred by inhaling or touching infected fluids.

### EIN-3.D.10

Middle East Respiratory Syndrome (MERS) is a viral respiratory illness that is transferred from animals to humans.

### EIN-3.D.11

Zika is a virus caused by bites from infected mosquitoes. It can be transmitted through sexual contact.

### EIN-3.D.12

Cholera is a bacterial disease that is contracted from infected water.