

## ***Bio 20 Biogeochemical Students Worksheet***

### ***Part A: Biogeochemical Cycles***

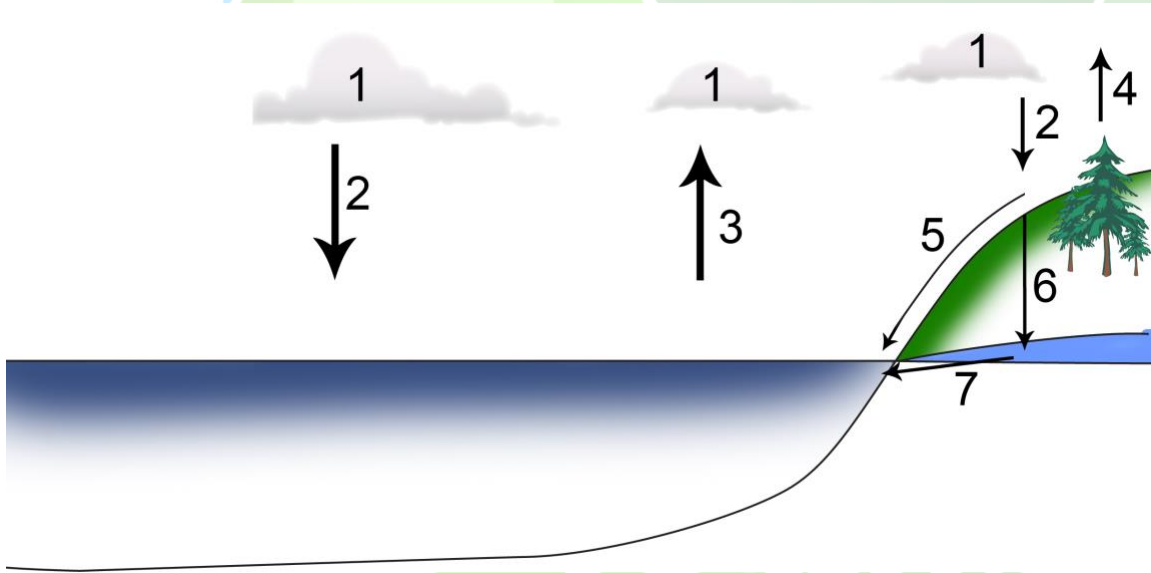
Go to [www.albertatomorrow.ca](http://www.albertatomorrow.ca) and register for a student account. Please do not use your real name in your username. Once you have created your account and logged in, find the videos on the left-hand side of your screen. "Videos".

#### **Water Cycle**

***1. View the Water Consumption Video.***

***Label the following diagram using these terms:***

Condensation, Percolation, Evaporation, Ground Water, Overland Flow, Precipitation, Transpiration



**Fill in the blanks:**

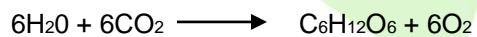
In the water cycle, \_\_\_\_\_ in the clouds causes \_\_\_\_\_ to fall to the earth's surface. Once on the ground, it may end up in water bodies directly, or be absorbed into the \_\_\_\_\_. Once in the soil, the water may be used by producers in the process of \_\_\_\_\_, or may eventually reach ground water. Energy from the \_\_\_\_\_ causes water on earth to \_\_\_\_\_ returning it back to the \_\_\_\_\_. Water may also return to the \_\_\_\_\_ from plants through the process of \_\_\_\_\_.

**Long Answer:**

1. Could the water cycle proceed as a cycle if there were no living things on earth? Explain.

2. List any biotic components to the water cycle.

3. Write out the formula for photosynthesis and cellular respiration. Circle water.



4. List any abiotic processes in the water cycle.

5. All rivers, streams and ground water eventually end up in the ocean yet the oceans never overflow. Explain.

6. What powers the water cycle?

7. What industries interfere with the water cycle?

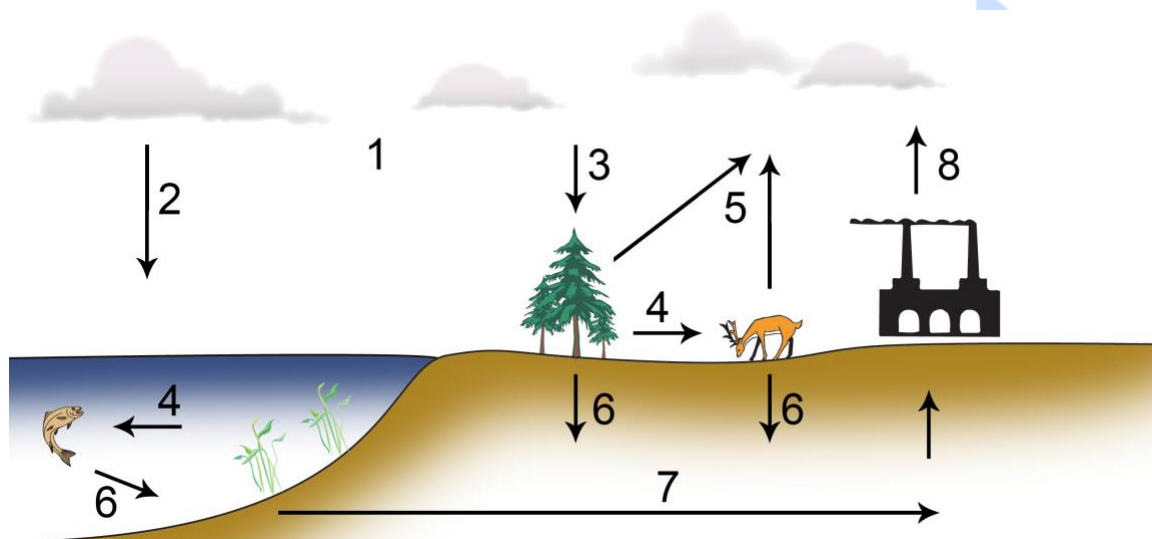


# Carbon Cycle

## 2. View the Greenhouse Gases Video.

Label the following diagram using these terms:

CO<sub>2</sub> in the atmosphere, Cellular Respiration, Death and Decomposition, CO<sub>2</sub> dissolved in water, photosynthesis, Combustion, Consumption, Fossil Fuels



### Fill in the blanks:

Carbon dioxide can be found in the form of \_\_\_\_\_ in the atmosphere, or can be dissolved in \_\_\_\_\_. CO<sub>2</sub> is used by producers in the process of \_\_\_\_\_. In this process, the carbon in CO<sub>2</sub> is incorporated into a molecule of \_\_\_\_\_. Animals acquire \_\_\_\_\_ when they \_\_\_\_\_ producers. CO<sub>2</sub> is released back to the atmosphere by plants and animals through the process of \_\_\_\_\_. Decomposition of waste and the remains of plants and animals releases CO<sub>2</sub> back to the \_\_\_\_\_. The same biotic processes can take place in water bodies.

If decomposition is delayed, under certain conditions, the remains of plants and animals may be converted into \_\_\_\_\_ including oil, gas and coal. The burning of fossil fuels, as well as natural processes such as \_\_\_\_\_ and \_\_\_\_\_ releases CO<sub>2</sub> back to the atmosphere.

### Long Answer:

- Which complementary biotic processes form an integral part of the carbon cycle?
- Write out the formula for photosynthesis and cellular respiration. Circle carbon dioxide.  

$$6\text{H}_2\text{O} + 6\text{CO}_2 \longrightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

$$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \longrightarrow 6\text{H}_2\text{O} + 6\text{CO}_2 + \text{ATP}$$

3. Explain how the earth's atmosphere produces the greenhouse effect.

4. What processes in the carbon cycle increase carbon dioxide?

5. What processes in the carbon cycle decrease carbon dioxide?

6. The carbon cycle is in effect in aquatic systems too. Refer to your textbook and write a short description of that cycling.

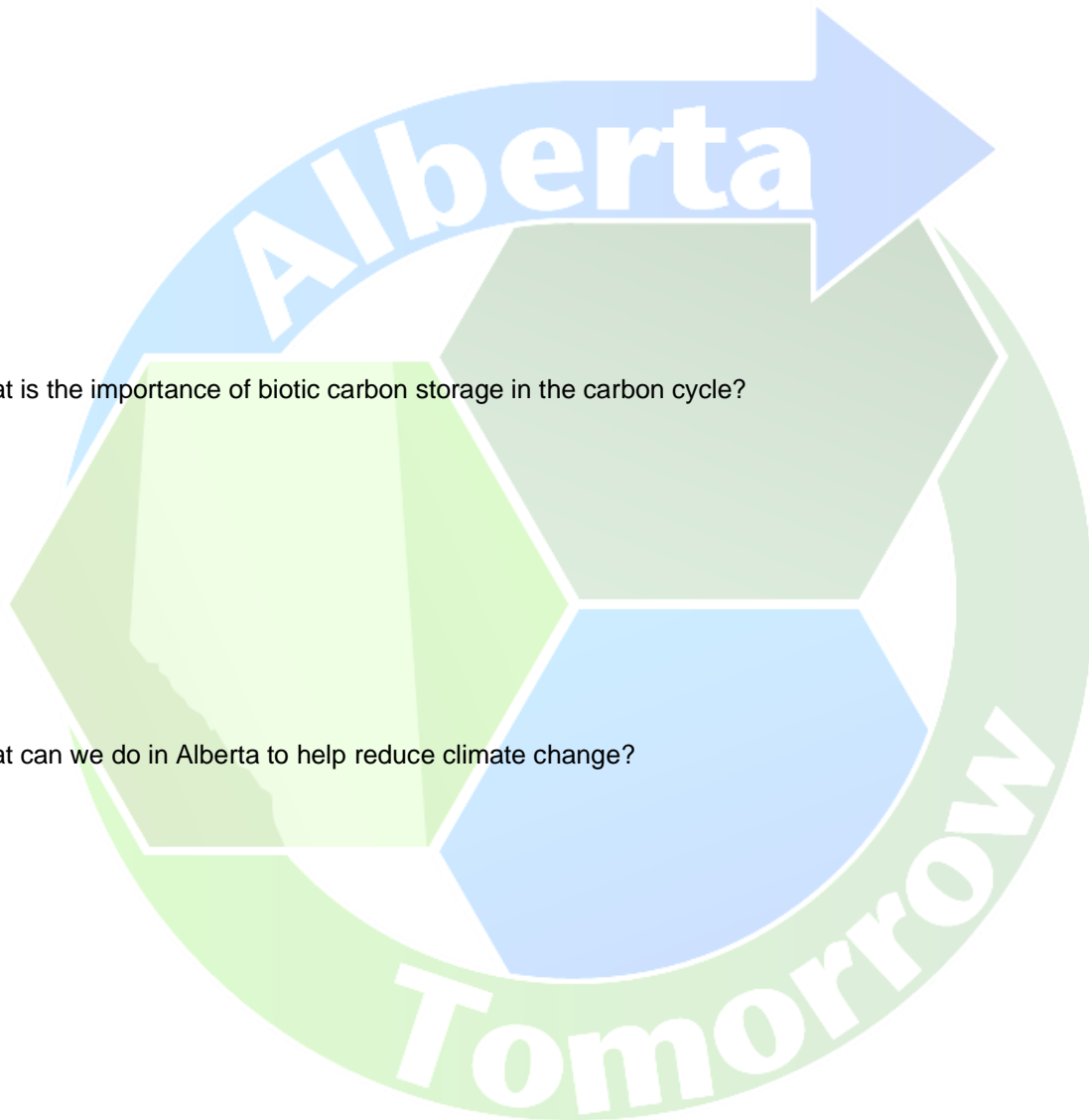
7. Explain why it is important to maintain the health of the carbon cycle?



8. How does a balance between photosynthesis and cellular respiration affect the atmospheric composition?

9. What is the importance of biotic carbon storage in the carbon cycle?

10. What can we do in Alberta to help reduce climate change?

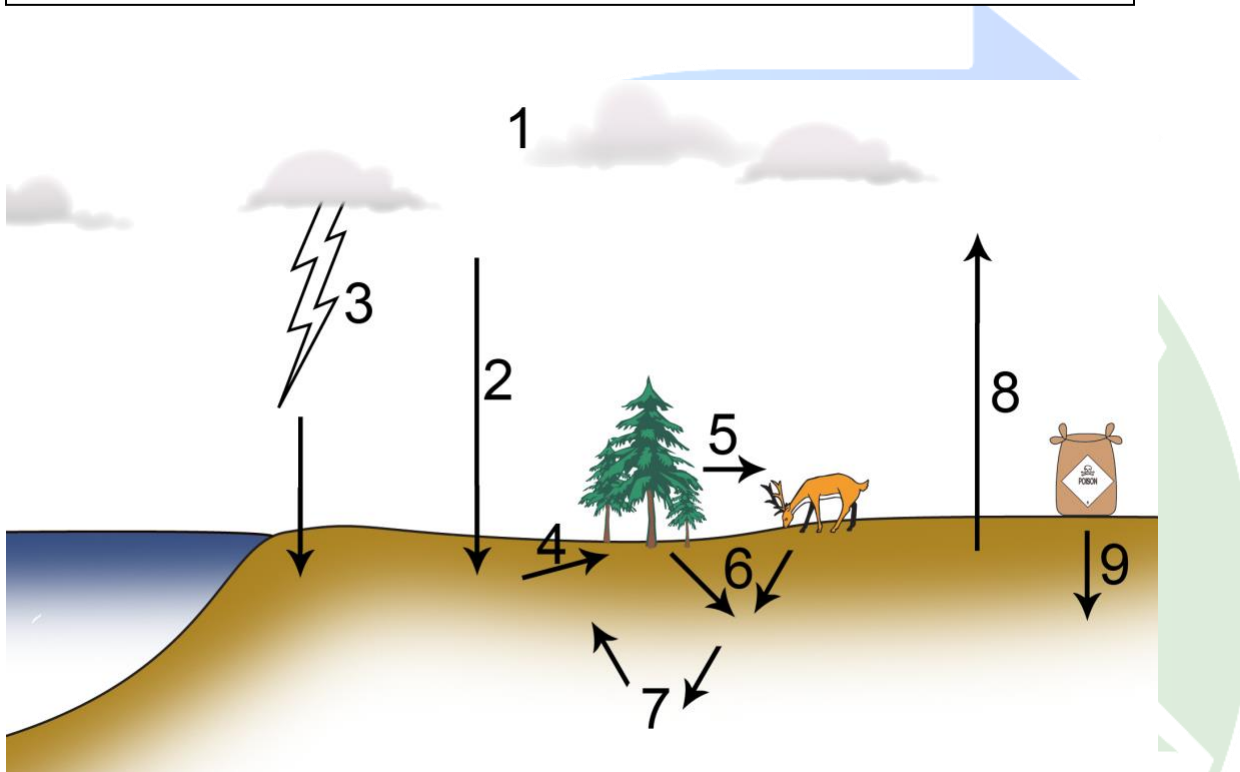


# Nitrogen Cycle

## 3. View the Water Quality Video.

Label the following diagram with these terms:

Fertilizer, Death and Decomposition, Nitrogen Uptake by Plants, Denitrifying Bacteria, Nitrogen Fixing Bacteria in Soil, Nitrogen in Atmosphere, Nitrogen Fixing Bacteria, Nitrogen Fixation by lightning, Consumption



### Fill in the blanks.

The reservoir of nitrogen is found in the \_\_\_\_\_ in the form of nitrogen \_\_\_\_\_. There are \_\_\_\_\_ ways in which this nitrogen can be converted into forms useable to living organisms. Lightning causes \_\_\_\_\_ to combine with oxygen to form \_\_\_\_\_. This newly formed molecule dissolves in rainwater and can enter the soil. \_\_\_\_\_ bacteria, usually found in soil, or in the root nodules of legumes such as clover and peas, can also form nitrates. If excess nitrates are made in the root nodules, it moves into the soil.


Plants use the nitrates to make DNA, and amino acids, which are joined together to make proteins. Animals eat the plants and break the proteins back down into \_\_\_\_\_ to make their own proteins.

When plants and animals die, or produce waste, the nitrogen containing compounds are returned to the \_\_\_\_\_ by decomposers. Bacteria convert the amino acids back into \_\_\_\_\_, which are once again taken up by the plant.

Other bacteria called \_\_\_\_\_ bacteria take the nitrates and convert it back into \_\_\_\_\_ gas which is released back into the atmosphere. These bacteria are anaerobic, meaning

they do not require \_\_\_\_\_ and grow best where there is none. They complete the nitrogen cycle.

**Long Answer:**

1. Nitrogen gas makes up almost 79% of the atmosphere. Why then is it so difficult for living organisms to acquire nitrogen?
  2. Explain how lightening plays a role in the nitrogen cycle.
  3. What role do decomposers play in the nitrogen cycle?
  4. What are nitrates?
  5. How do denitrifying bacteria affect your lawn?
- 



6. Why do farmers often practice crop rotation?

7. How do humans affect the nitrogen cycle?

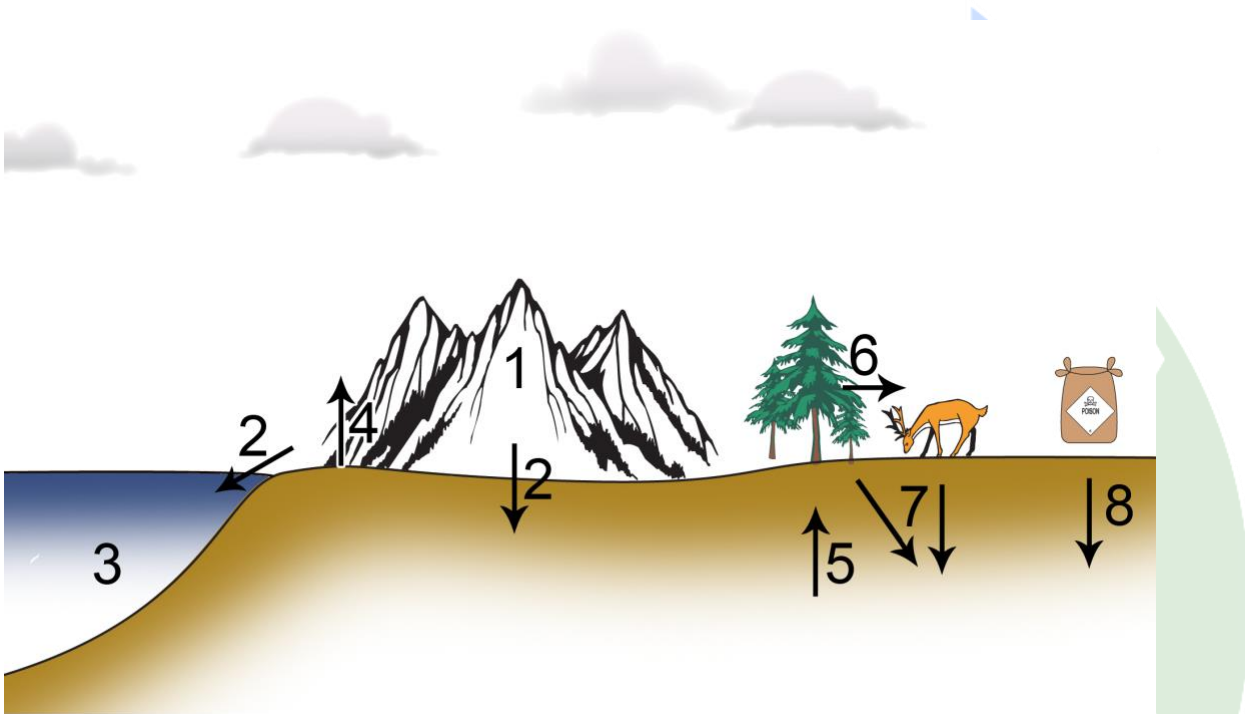
8. Define and describe Eutrophication.



# Phosphorus Cycle

## 4. Label the following diagram using these terms:

Fertilizer, Consumption, Geologic Uplift, Phosphorus in Soil, Erosion, Phosphorus in rocks, Death and Decay, Phosphorus in ocean sediments,



### Fill in the blanks:

The phosphorus cycle has two different parts: a long-term cycle and a short term cycle. The long-term cycle involves the formation and erosion of \_\_\_\_\_. The short-term cycle involves \_\_\_\_\_ and \_\_\_\_\_.

Through erosion, \_\_\_\_\_, a combination of phosphorus and oxygen, end up in the soil and water bodies. Here they can be used by \_\_\_\_\_ to make DNA. \_\_\_\_\_ eat the plants and obtain calcium phosphate for bones. In the marine environment, when plants and animals die, they form rock on the ocean floor. Over millions of years, this rock may come to the surface through geologic uplift. This is the \_\_\_\_\_ term cycle.

The \_\_\_\_\_ term cycle involves decomposers. The waste and remains of plants and animals are converted back into \_\_\_\_\_, which can again be taken up by \_\_\_\_\_.

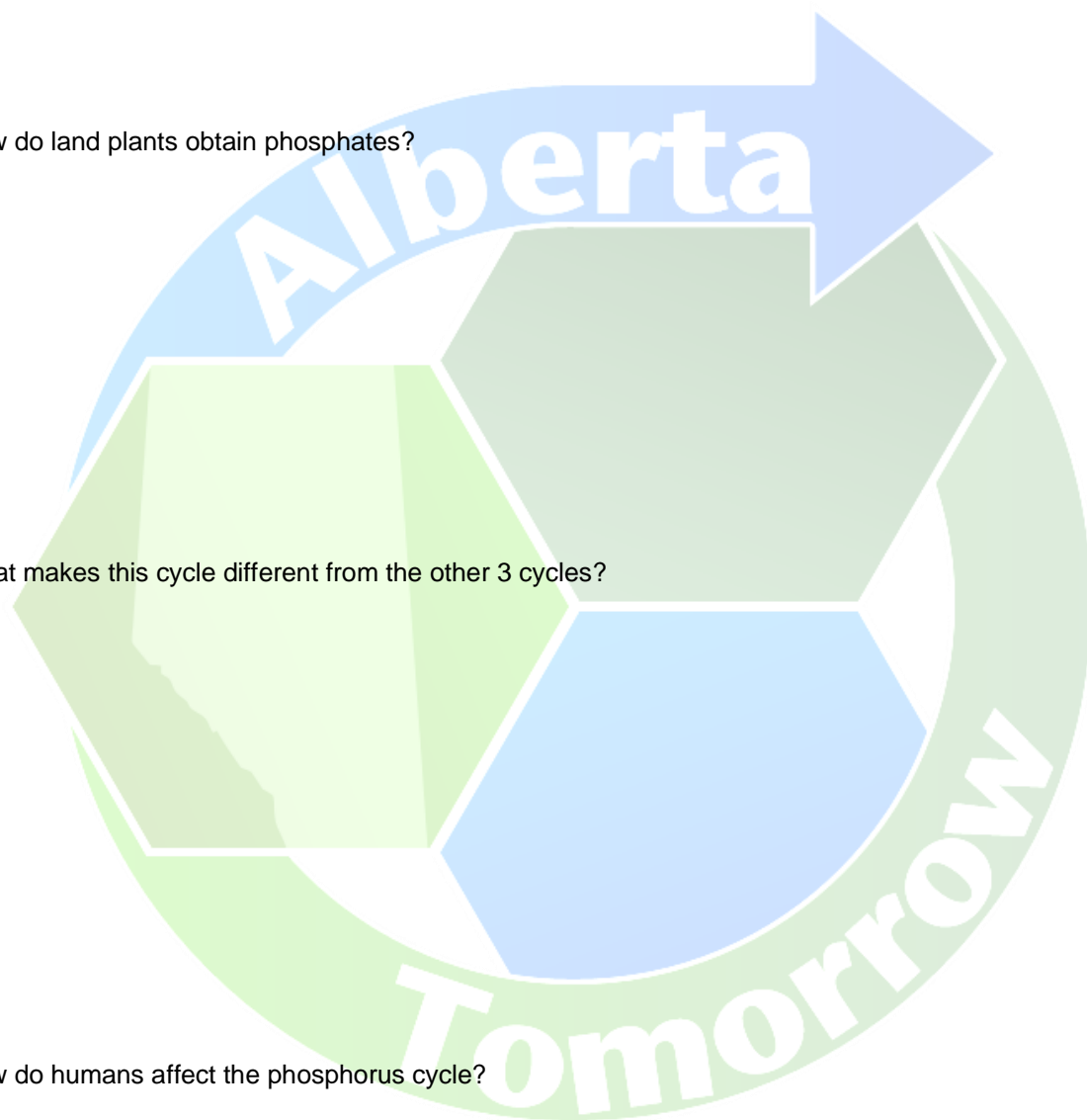
### Long Answer:

1. What are phosphates?

2. How do land plants obtain phosphates?

3. What makes this cycle different from the other 3 cycles?

4. How do humans affect the phosphorus cycle?



5. An ecological indicator is a variable that is measured to determine the health of a component of the ecosystem. Explain why phosphorus runoff is a good indicator of the status of the phosphorus cycle.



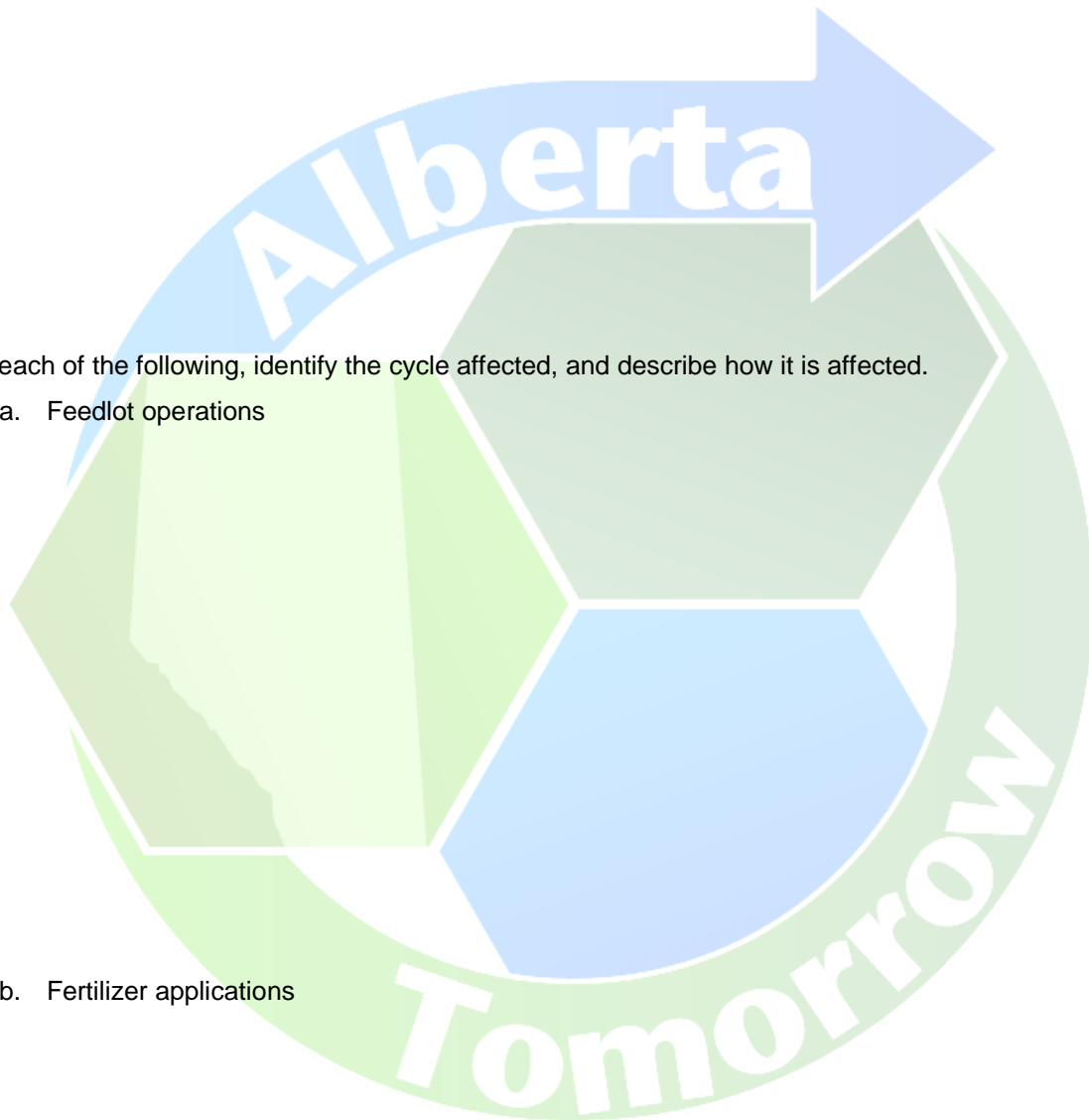
## Biogeochemical Cycle Review:

1. What is a biogeochemical cycle?

2. For each of the following, identify the cycle affected, and describe how it is affected.

a. Feedlot operations

b. Fertilizer applications



c. Sewage disposal

d. Vehicle and refinery emissions

3. How is water quantity and quality affected by the following:

a. Oil and gas industry

b. Agricultural systems



c. Domestic water consumption

4. Explain five ways you could reduce your impact on biogeochemical cycles.



## VIDEO QUESTIONS:

1. *Watch the Introductory video*
2. Define Sustainable Development:

3. *Watch the Natural Landscapes video.*
4. What region of Alberta do you live in?

5. What type of land-use is present in your area?

6. Why is native prairie important?

7. *Watch the Mammal Habitat video.*
8. How much woodland caribou habitat is left in Alberta?

9. How does human disturbance affect caribou?

10. What are the factors that make Grizzly Bears populations so susceptible to decline?





11. What can be done to help Grizzly Bear populations?

12. *Watch the Fish Habitat Video.*

13. What do fish populations need to thrive?

14. How does human activity affect fish populations?

15. *Watch the Water Quality Video.*

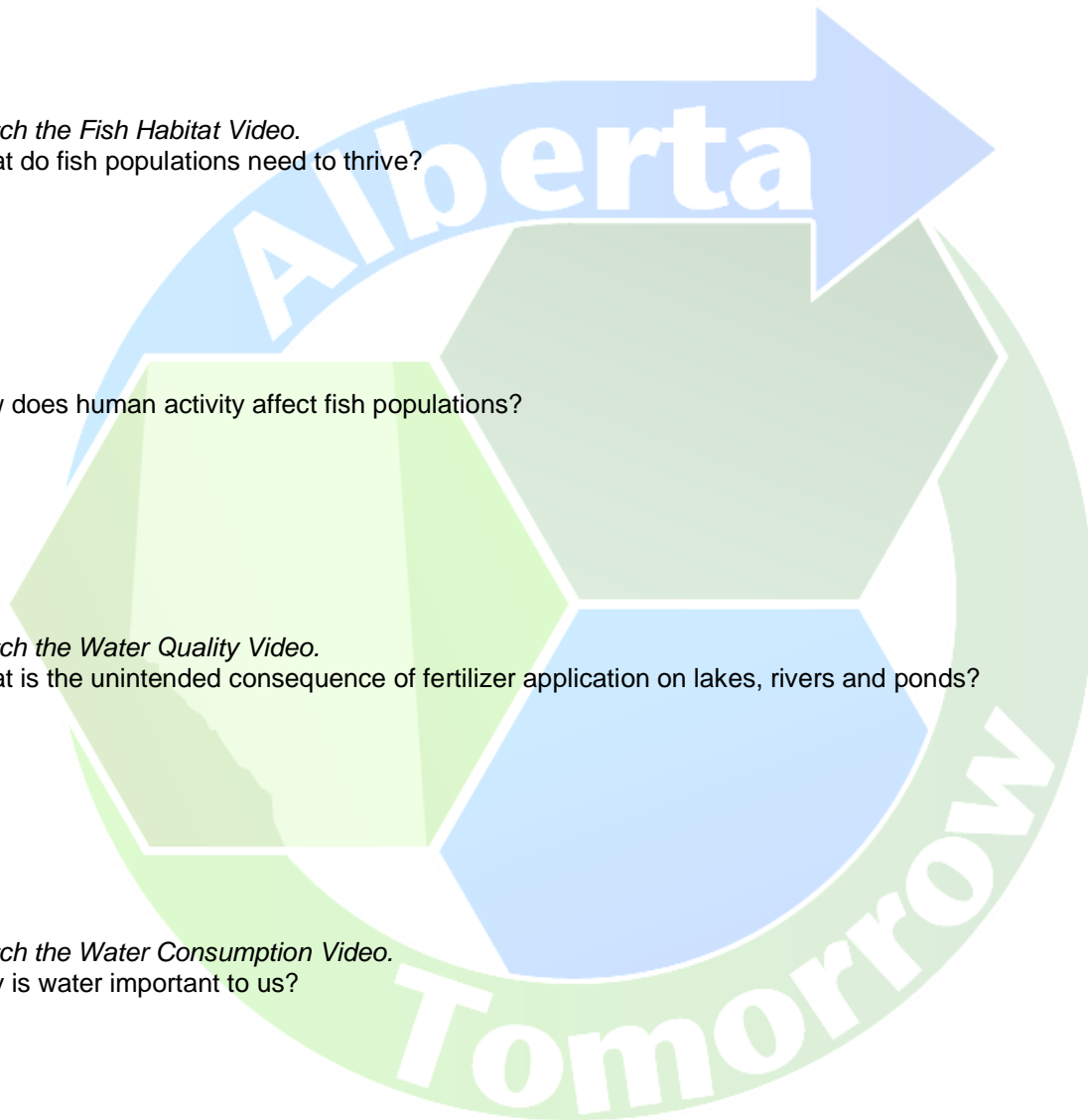
16. What is the unintended consequence of fertilizer application on lakes, rivers and ponds?

17. *Watch the Water Consumption Video.*

18. Why is water important to us?

19. *Watch the Greenhouse Gas and Biotic Carbon Storage Video.*

20. Describe the flow of carbon through an ecosystem.



21. Watch the GDP and Human Population Videos.  
22. How does Alberta compare to the rest of Canada?

23. Watch the following three videos: Oil and Gas Production, Forestry, and Agriculture Production Videos

24. For each type of natural resource production describe the benefit to Albertans.

a. Oil and gas

b. Forestry

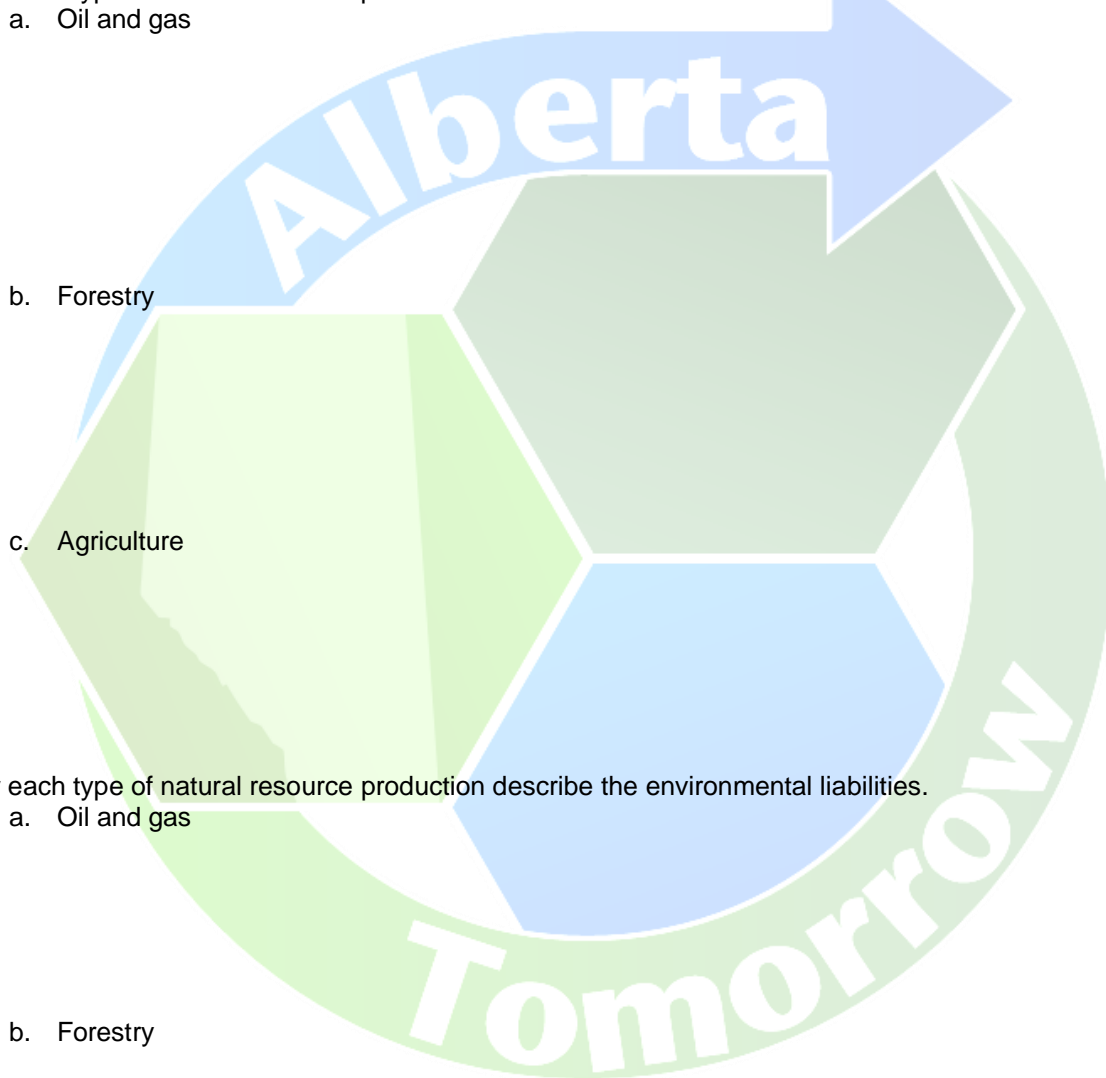
c. Agriculture

25. For each type of natural resource production describe the environmental liabilities.

a. Oil and gas

b. Forestry

c. Agriculture



26. Watch the *Best Practices* video.  
27. What do best practices do?

28. List some of the best practices currently being used in Alberta.



## Part B: Land-Use Assessment

1. Click on "Explore". Zoom in and find your school, or house. Click on the green "+ Scenario" button at the top. Click on "Create New Scenario" Create a "Historic" scenario for your watershed. Click on your desired watershed. You may look at sub-watersheds also. Once you have chosen your study area, click "Run Scenario".

2. What watershed do you live within?

Watersheds are the sum of the streams that gather from heights of land and flow into a common water basin. Sometimes called catchment basins, watersheds are made up of many sub-basins, or tributary basins

I live within the \_\_\_\_\_ drainage basin, the \_\_\_\_\_ watershed and the \_\_\_\_\_ sub watershed (s)

Where does the water in your watershed begin? Can you tell through which river the water in your watershed leaves the province?

Can you tell what ocean that water will eventually drain into?

3. Colors on the map overlay correspond to landscape types/landuses:

Landscape Type/ Landuse	Color
Orange	Agriculture
Yellow	Natural Grassland
Blue	Water
Light Green	Wetland
Dark Green	Forest
Purple	Urban
Grey	Industry and Transportation
White	Alpine and Exposed

4. "Fill out Chart 1 and Chart 2 for 1910
5. List the top 3 changes you see on the map:

•  
•  
•

6. From Chart 1, complete these observations;
  - when natural landscapes went down..... went up.
  - when oil and gas production went up, ..... went up/down.
  - when agriculture went up.....went up/down.

Create 3 more observations:

• .....  
• .....  
• .....

7. Click "+scenario". This time, choose "Business as Usual"

Complete Chart 1 and 2 for the year 2050

8. List 3 WOW's you have after seeing this projected future:

- 
- 
- 

9. Look at the changes in environmental indicators. Which abiotic factors decreased?

10. Which biotic factors decreased?

11. Identify the environmental indicators that increased. Are they abiotic or biotic? What was the change?

12. Historically the human population in Alberta has increased exponentially. What impact does population growth have on water consumption?

13. Using your knowledge of biogeochemical cycles, what impact does population growth have on agriculture? (Use specific values from the simulator dials). Explain.



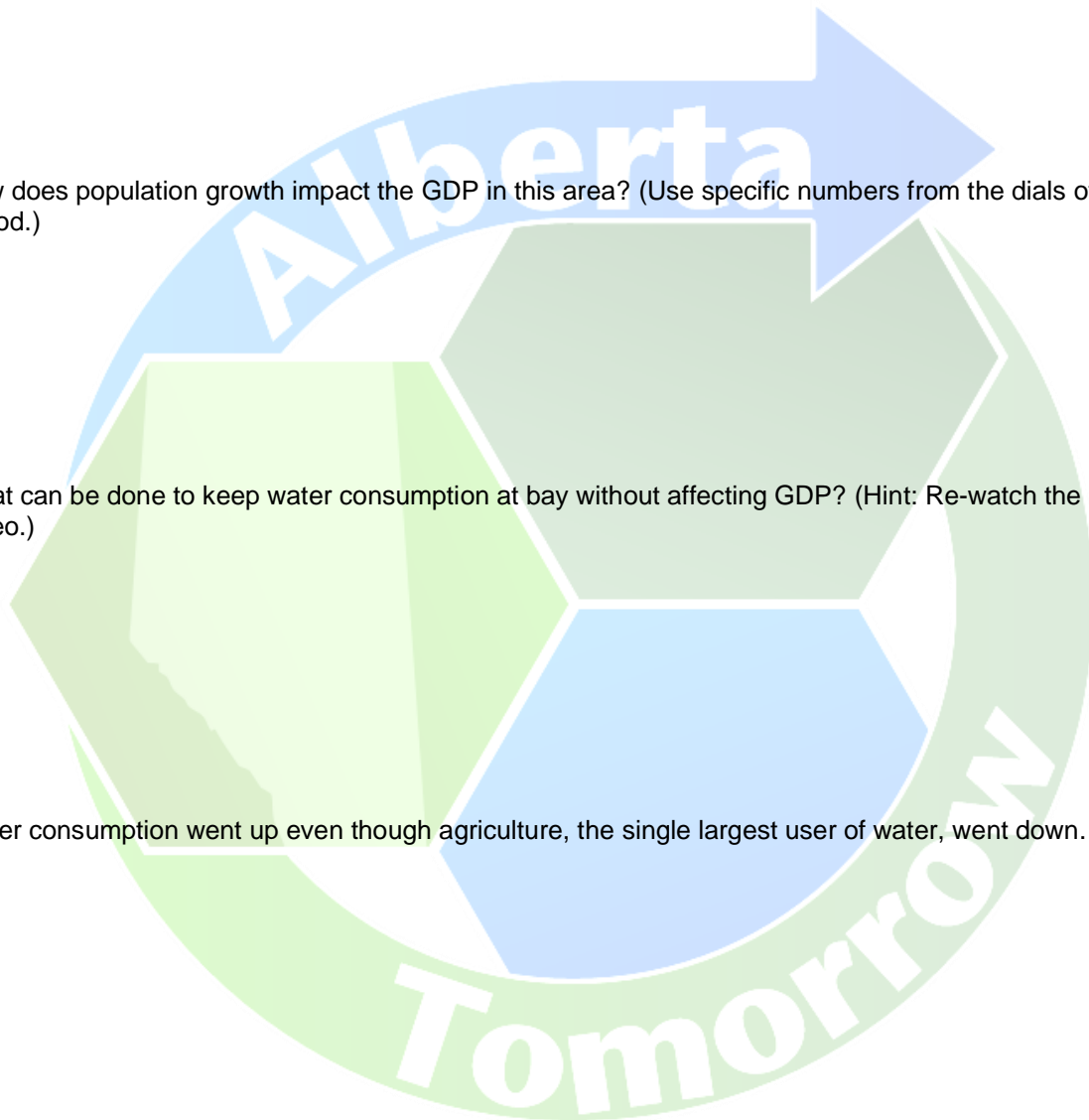
14. Explain the relationship between population growth and water consumption and population growth and agriculture. (Use specific values from the simulator dials).

15. How does population growth impact the GDP in this area? (Use specific numbers from the dials of each time period.)

16. What can be done to keep water consumption at bay without affecting GDP? (Hint: Re-watch the Best Practices Video.)

17. Water consumption went up even though agriculture, the single largest user of water, went down. Explain.

18. What unintended consequences resulted from an increase in GDP and what is the impact on air and water quality?



19. Is there another measuring tool that can be used to replace GDP that measures social, environmental and economic well being? Explain. (Hint: Research Genuine Wealth Index)

20. What are Ecological Goods and Services? Give 2 specific examples.

21. What conclusions about environmental and socio-economic indicators can be drawn from the changes in your study area?

22. If historical rates continue, predict what will happen in your area in another 30 years.



## **Part D: Future Land Use Planning**

1. Click on "Create New Scenario" Choose "Landuse"
2. Choose your study area, and then click "Next" (Remember, the smaller the study area the harder it is to see change.)

3. You are seeing the current land use.
4. What you see on the indicator dials are the levels as of 2020. Your first job is to set goals for 30 years from now. Move the goal slider to where you want the indicator to be in the year 2050. (if you are unsure of what the indicator is measuring, click on it and watch the video) Remember to set realistic goals.
5. Record Current values and goals on Chart 3 and Chart 4
6. Click "Next" You will now decide how you will reach your goals by changing the landscape. Click on "changes"
7. Choose the landscape type or landuse you wish to add in the future and click the location where you want it to grow. ie, if you want to have more grassland in the future, click on the yellow grassland icon and then click on the map where you want to increase grasslands in the future. Remember, the simulator will only allow that change to be made if it is possible to change the current landscape type/landuse to what you want.
8. Record the change you requested on Table 4 You may choose to adjust the level of Industrial Activity, which beneficial management practices you want to use, and which Climate Change scenario you wish to see, or save this step for later and click "Next".
9. Click "Run Scenario" and then click "Play"
10. Record whether you reached your goals or not (the goal dot will be green if you reached your goal, yellow if you got close, and red if you didn't reach your goal.)

### Management Practices

Now click on Management Practices. Watch the management practice video. You must make a decision on how much industrial activity you want in the study area and what management practices you wish to use from this year on.

11. Move the Industrial Activity slider to the level you wish to see moving into the future. Record your level.  
\_\_\_\_\_
12. Choose which Management Practices you wish to use. Record this on Chart 4

If you still have not reached your goals, you can go back and change your goals by clicking on individual goals, or go back and make more changes to the landscape by clicking on landscape changes.

### Analysis

1. How would you summarize your landuse plan? What were you trying to achieve?
2. Which goals were you not able to reach? Why or why not? What is the impact of not reaching these goals?





### Summary Questions:

1. Give 4 examples of how our land-use affects the Biogeochemical Cycles.
2. Explain how technology can have both intended and unintended consequences for the environment and therefore humans.
3. A land use trade-off occurs when decreasing one land use goal makes it easier to achieve another land use goal. Describe a land use trade-off that you encountered while building your sustainable land use plan.
4. Why do land-use tradeoffs make sustainable development challenging?



CHART 1: Indicator Dials	1910	2020	2050
Natural Landscape			
Grizzly Habitat			
Fish Habitat			
Water Quality			
Biotic Carbon Storage			
Greenhouse Gases			
Population			
GDP			
Oil and Gas Production			
Forestry			
Agriculture			
Water Consumption			

CHART 2: Area	1910	2020	2050
Agriculture			
Grassland			
Water			
Wetlands			
Forests			
Urban Area			
Industry			
Alpine			

CHART 3: Dials	2020	My Goal	Result
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Natural Landscape			
Grizzly Habitat			
Fish Habitat			
Water Quality			
Biotic Carbon Storage			
Greenhouse Gases			
Population			
GDP			
Oil and Gas Production			
Forestry			
Agriculture			
Water Consumption			

CHART 4: Area	2020	Change Requests	Result 2050
Agriculture			
Grassland			
Water			
Wetlands			
Forests			
Urban Area			
Industry			
Alpine			

Chart 5	Management Practices Used	Results	Comments
First attempt			
Second attempt			
Third attempt			