Name _____ Class _____ Date _____

Exploration Lab

MODELING

Modeling Water Budgets

A **water budget** describes the relationship between all of the water that moves into and out of a region. Incoming water is precipitation (P), which includes rain, snow, sleet, and hail. Outgoing water is water that leaves a region through use, as runoff, or as a result of evapotranspiration (E). **Evapotranspiration** includes two processes: evaporation and transpiration. **Evaporation** occurs when water enters the atmosphere as the result of an increase in air temperature. **Transpiration** is a process whereby water is released into the atmosphere by the leaves of a plant.

A water budget is balanced when the volume of precipitation over a region is equal to the volume of water that leaves the region. When the volume of precipitation exceeds water loss, there is a **surplus** in the region's water budget. When the volume of precipitation is less than the volume of water that leaves a region, a **deficit** exists in the region's water budget. In this laboratory activity, you will model the water budget of two cities. Then you will construct double-line graphs using water budget data from the cities.

OBJECTIVES

Model the water budget of two different cities.

Distinguish between a water budget surplus and a water budget deficit.

Graph water budget data from two cities.

MATERIALS

- beaker (600 mL or 1000 mL)
- calculator (optional)
- clear plastic pitcher, tall (at least 50 cm) (2)
- lab apron
- map
- marker, permanent, fine-lined
- metric ruler
- overflow pan
- paper towels
- pencils, colored (4)
- pipette
- scissors
- tape, clear, wide
- water

Procedure

PART I—WATER BUDGET FOR CITY ALPHA

1. Put on your lab apron. Use the paper towels to immediately wipe up any spills onto your work area or the floor.
2. Measure and cut a piece of tape that is as long as the pitcher is high.
3. Gently place the tape onto the edge of a clean, flat surface.

4. Use the ruler and the fine-tipped marker to mark off and label along one edge of the tape in 5-mm increments.
5. Remove the tape from the surface and place it securely onto the pitcher, [vertically] parallel to the height of the pitcher.
6. Put this pitcher with the scale into the overflow pan.
7. Fill the beaker with water. Use the pipette to transfer water to the pitcher, or remove water from the pitcher. The data in Table 1 shows which action should be taken. For example, during January, 47 mm of precipitation fell over City Alpha. To represent this month, you would add 47 mm of water to the pitcher. You would remove no water for this month.
8. As you work through each month in step 7, record the water budget total in the data table. The water budget total is the total amount of water in the pitcher at the end of each month. The first two months have been filled in for you.

Table 1: Precipitation (P) and Evapotranspiration (E) for City Alpha

Month	J	F	M	A	M	J	J	A	S	O	N	D
P (mm)	47	58	80	86	80	65	69	61	42	43	40	37
E (mm)*	0	0	0	0	24	93	120	100	57	0	0	0
Water Budget (mm)	47	105										

*This value is all of the water that could potentially enter the atmosphere in the given region during the given month.

PART II—WATER BUDGET FOR CITY BETA

9. Pour out all of the water from the pitcher with the scale.
10. Repeat steps 7 and 8 using the data for City Beta from Table 2.

Table 2: Precipitation (P) and Evapotranspiration (E) for City Beta

Month	J	F	M	A	M	J	J	A	S	O	N	D
P (mm)	17	20	42	62	81	32	42	37	39	34	26	18
E (mm)*	0	0	0	65	127	207	103	37	33	32	13	0
Water Budget (mm)												

*This value is all of the water that could potentially enter the atmosphere in the given region during the given month.

Analysis

1. **Examining Data** Describe the overall water budget for City Alpha during the year shown above.

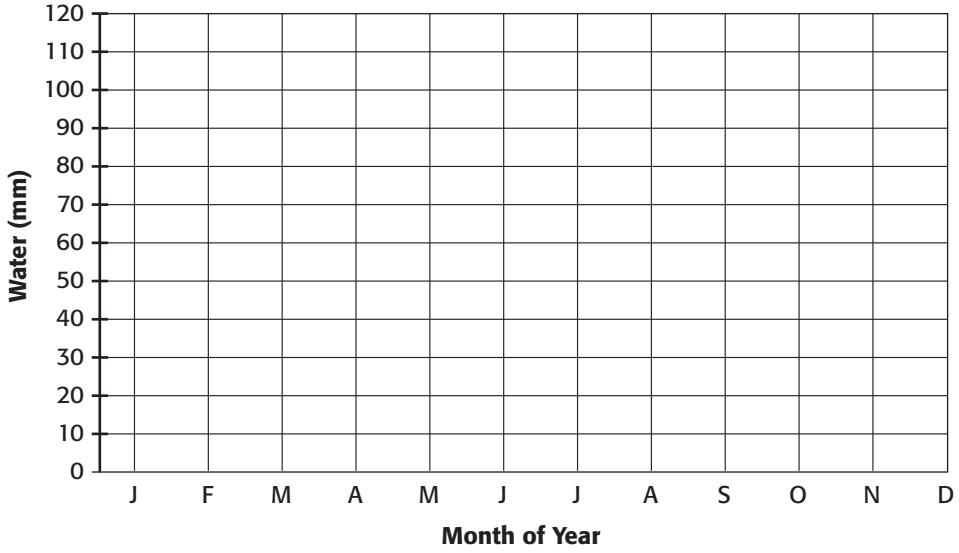
2. **Recognizing Patterns** Did City Alpha experience any monthly water deficits? If so, when?

3. **Examining Data** Describe the overall water budget for City Beta during the given year.

4. **Recognizing Patterns** Did City Beta experience any monthly water surpluses? If so, when?

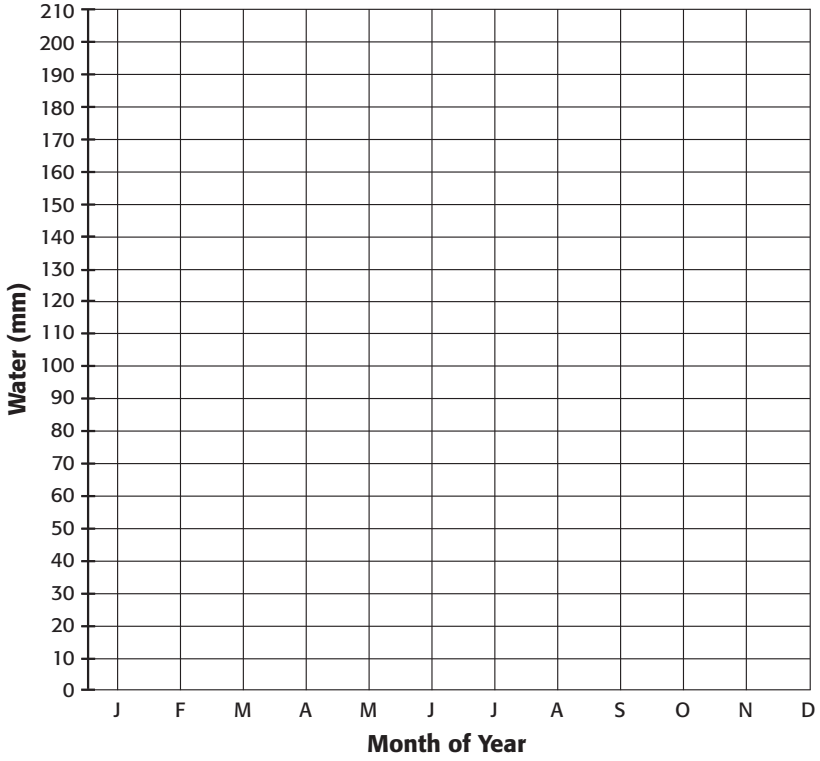
5. **Constructing Graphs** Use colored pencils to create a double-line graph showing precipitation and evaporation for City Alpha. Plot the volume of water on the y-axis and the month of the year on the x-axis. Use different colors to shade the areas on the graph that represent times of surpluses and deficits. Create a key for your graph.

Water Budget City Alpha



6. Constructing Graphs Create a second graph of the water budget data for City Beta. Follow the same directions as in step 5.

Water Budget City Beta



Conclusions

7. **Analyzing Graphs** During which month is City Alpha's water deficit the smallest? The largest?

8. **Analyzing Graphs** During which month is City Alpha's water surplus the smallest? The largest?

9. **Analyzing Graphs** During which month is City Beta's water deficit the smallest? The largest?

10. **Analyzing Graphs** During which month is City Beta's water surplus the smallest? The largest?

11. **Applying Conclusions** City Beta is downstream from City Alpha. What might happen if City Alpha experienced a large water budget surplus during the months of March and April?

12. **Interpreting Information** What happened to the total water budget in your pitcher model for City Beta with your water additions and removals as you worked through the months in the year?

13. **Interpreting Information** If City Beta were an actual city, what would really happen once the water budget deficit exceeded the surplus?

14. **Applying Conclusions** In what ways might City Beta replenish its water budget supply?