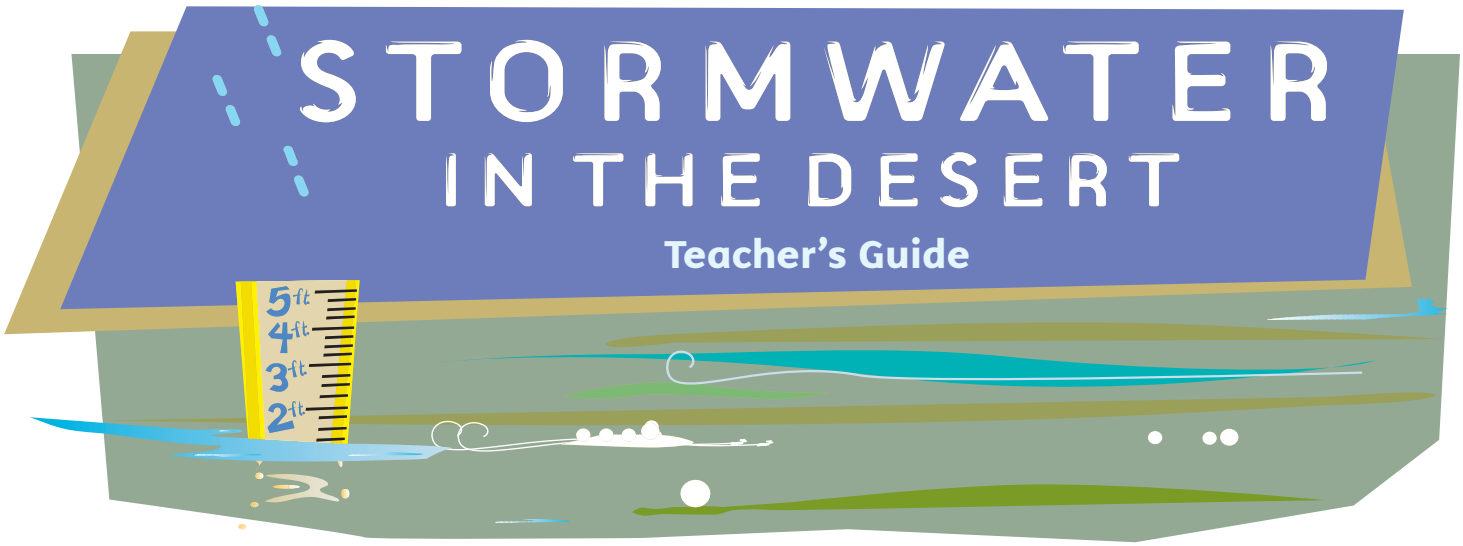
STORMWATER IN THE DESERT

Teacher's Guide



Welcome to ***STORMWATER IN THE DESERT***! The Town of Gilbert (https://www.gilbertaz.gov/stormwater) and Arizona STormwater Outreach for Regional Municipalities (AZSTORM at www.azstorm.org) are proud to present this exciting curriculum designed to educate middle school students about the water cycle, weather patterns, watersheds, stormwater, and other related science and engineering topics. ***STORMWATER IN THE DESERT*** includes a variety of hands-on, interactive activities that are relevant, engaging, and learning-expansive for students. This *Teacher's Guide* accompanies ***STORMWATER IN THE DESERT: A Middle School Activity Book***.

Each section in the activity book includes background and explanatory information, an *Activity* or two that can be completed in the book, *Try This* challenges that extend student post-book learning, and multiple *Get Online* resources that direct students to the Internet for further exploration. This *Teacher's Guide* provides:

- Key concepts
- Correlated Arizona Department of Education (ADE) standards
- Brief descriptions of each *Activity*, *Try This* challenges and *Get Online* research opportunities
- Materials lists, suggested procedures, and lesson extension ideas
- Accompanying activity data sheets that can be photocopied for student use
- Additional resources

It is recommended, but not necessary, that the concepts in the student activity book be taught in order. Teachers should feel free to pick and choose activities that are relevant to their curriculum and standards. Students are encouraged to use the included data sheets and/or science notebooks, if an option.

By implementing ***STORMWATER IN THE DESERT***, teachers are meeting their curricular standards and also introducing their students to a relevant and ever-growing environmental issue in the Phoenix and Central Arizona regions.

STORMWATER IN THE DESERT was developed in proud partnership of STORM and the Environmental Education Exchange, a non-profit organization focused on increasing environmental literacy. For outreach opportunities or assistance with ***STORMWATER IN THE DESERT***, please visit the Exchange's website at https://www.eeexchange.org/.

Thanks for teaching stormwater to your students!

Town of Gilbert and AZSTORM

Teacher's Guide Overview

This *Teacher's Guide* provides the following for each section in the activity book:

KEY CONCEPTS: The key concepts are articulated to convey the essential ideas presented in each section and should serve as a guide to help teachers (and students) focus on the important ideas of the section, and what students should be expected to understand upon completion of each section.

CORRELATED ARIZONA DEPARTMENT OF EDUCATION (ADE) STANDARDS: The correlated ADE standards for grades 6, 7, and 8 are presented for each section of the activity book. In the *Teacher's Guide*, the standards are listed in code at the beginning of each section, as well as in an articulated matrix at the end. Listed standards apply to only the content and activities in the student activity book, and not the extensions in the *Teacher's Guide*. Additional ADE standards may be applicable if a teacher chooses to extend or modify activities.

ACTIVITY

Activity: Each *Activity* includes all the background information, instructions, materials and work pages necessary to complete the activities. Answers to these activities are presented at the end of the book.

TRY THIS

Try This: *Try This* activities are "hands-on" opportunities for the students to gain an even better grasp of the concepts presented in the readings. These activities are fun, engaging, and require minimal materials to conduct. This Teacher's Guide was created primarily to help teachers conduct these activities with their students and to provide student data sheets for more focused learning.

Get Online

Get Online: *Get Online* activities direct students to the Internet to further their investigations of stormwater. Teachers are encouraged to pre-visit the sites and review the activities before conducting with students. *(NOTE: Often, websites change or become inactive over time. As needed, teachers are encouraged to explore alternate resources specific to the intended content.)*

EXTENSIONS: For many content sections in the book, extension ideas are offered. These appear in the *Teacher's Guide* only, and not in the student activity book, and are intended as springboard ideas for the teacher for deeper and applicable learning opportunities.

ADDITIONAL RESOURCES: An annotated list of additional curricula and websites is presented at the end of this *Teacher's Guide*. This is provided to encourage teachers to explore the myriad of options for teaching about stormwater and/or water resources around Central Arizona.

Stormwater in the Desert?

Activity Book, pages 2-5

KEY CONCEPTS:
The Central Arizona region has two distinct rainy seasons – one in the winter and one in the summer.

Winter's rains originate in the northern Pacific Ocean (to the west) and tend to be gentle and steady, covering larger areas and lasting for a longer duration than summer storms.

Summer's rains are called ''monsoons.'' Winds originate from the south over the Gulf of Mexico and blow northward. Hot summer temperatures cause moisture to rise into the atmosphere, where it condenses and generates thunderstorms, which result in brief, intense periods of rainfall.

Although we live in the desert, we receive enough rainfall to cause flooding.

Because urban settings are built right on top of natural watercourses and drainage systems, stormwater management is important.

CORRELATED ADE STANDARDS:
Science: SC06-S1C2-04, SC06-S1C2-05, SC06-S1C3-04, SC06-S6C2-05, SC07-S1C2-04, SC07-S1C2-05, SC08-S1C2-04, SC08-S1C2-05
Math: 6.NS.B.2, 6.NS.B3
Social Studies: SS06-S4C1-03, SS06-S4C1-04, SS06-S4C2-01, SS06-S4C5-02, SS06-S4C5-03, SS07-S4C1-03, SS07-S4C1-04, SS07-S4C5-02, SS07-S4C5-03, SS07-S4C5-05, SS08-S4C1-03, SS08-S4C1-04, SS08-S4C5-03
ELA: 6.SL.1, 6.SL.2, 6.W.3, 6.W.4, 7.SL.1, 7.W.3, 7.W.4, 8.SL.1, 8.W.3, 8.W.4 *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*
Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

TRY THIS Measuring Rainfall (page 3)

MATERIALS:

- Rain gauge/s
- *Stormwater in the Desert? Rainfall Data Sheet (below)*

SUGGESTED PROCEDURES:

As a class, monitor rainfall throughout the year. Acquire one or more rain gauges for a whole-class or student team exercise. Gauges may be purchased inexpensively at your local hardware store.

Place the rain gauge outside on a level surface, away from any overhanging eaves or trees. You may place the rain gauge directly in the ground or construct a simple stand to elevate the gauge above the ground. Leave the rain gauge outside for the entire school year.

Make a copy of the *Rainfall Data Sheet* (2 pages, or ample copies for teams) and post them in the classroom where students may record daily rainfall data. If there is no rain, a "0" should be entered.

For the rainy summer months, plan ahead and measure rainfall at your own home and record the data for the upcoming year's students. This will allow for more accurate data to be observed by the end of the school year.

NOTE: Because Central Arizona receives so little rain, students will not need to go outside and check the rain gauge except following rain events. When it does rain, rainfall data should be measured and recorded each day at around the same time as early in the morning as possible. After rainfall has been recorded, the rain gauge should be emptied for the next day's recording.

EXTENSIONS:

Encourage students to acquire a rain gauge to gather data at home with their families. Print extra copies of the data sheets for those students.

Integrate math! Review types of visual displays and guide students to determine the most appropriate display for the rainfall data (a bar graph is ideal). Students plot the rainfall data each month and graph. For added depth and comparison, students can research past years' monthly data to construct a double or triple bar or line graph. Examine, discuss patterns or trends, and make predictions as to future years' data. Encourage students to justify the reasoning for their predictions.

Stormwater in the Desert?

Rainfall Data Sheet

Name _____ **Location of Rain Gauge** _____
Class _____

Day	Jan	Feb	Mar	Apr	May	Jun	Notes
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
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31							
AVG							

Stormwater in the Desert?

Rainfall Data Sheet

Name _____ **Location of Rain Gauge** _____
Class _____

Day	Jul	Aug	Sept	Oct	Nov	Dec	Notes
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
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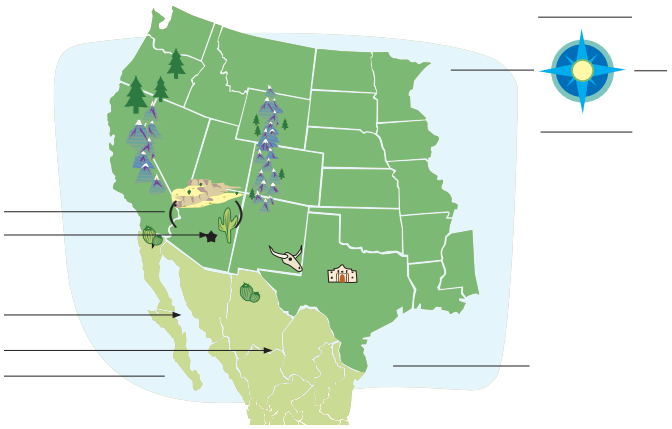
ACTIVITY

Know Your Weather (pages 4-5)



MATERIALS: None

SUGGESTED PROCEDURES:
Students draw arrows on and label a map to indicate the origin and wind direction of Central Arizona's winter and summer storms. Then, they use descriptive words to compare and contrast these different types of storms.

EXTENSIONS:
Students log onto the National Oceanic and Atmospheric Administration's (NOAA) website at http://www.noaa.gov. Click on "Weather" at the top left tool bar, then scroll down to "Satellites". Here, they can examine real-time looped satellite imagery for the latest 24-hour period, plus a global archive over multiple months. Explore various layers of satellite imagery, such as water vapor and infrared. What do these represent and how do they differ from the global view?

Explore weather satellite science even further! Introduce students to basic satellite science and learn about the satellite fleet, real-time locations and launchings, history, and how satellites work at https://www.nesdis.noaa.gov/content/our-satellites.

Searching for weather- and satellite-related games and apps? Visit https://scijinks.gov/menu/games/.

In teams, students can research Internet sources to locate Central Arizona's (Phoenix) annual rainfall amounts for the past 10 years. After recording their findings, discuss any trends observed. Prompt students to think about how our rainfall in a desert climate affects our water supply.

TRY THIS Remembering Rain (page 5)

MATERIALS:

- None
- Optional rain-related recordings or other "watery" sounds may be used, such as a rain stick, thunder maker, making "rain" with hands on desks, etc.

SUGGESTED PROCEDURES:

Conduct a visioning exercise with your students to help them remember rain. In the activity book, students are asked to describe a rainstorm they remember. By setting the stage and mood, you can help them remember details about a specific storm or storms they have experienced in the Sonoran Desert. Consider lowering the lights and/or playing rain-related sounds for the activity.

Have students close their eyes, then ask them to imagine a rain storm they have experienced in the desert. Ask them to imagine they are in that storm right now. Ask questions such as:

What is it like?
Is it a cold, winter rain or a warm, muggy summer rain?
Is the wind blowing?

As the visioning progresses, help students think of more details by asking questions such as:

Was there a flood?
Was there lightning?
What other sounds can you remember?
What did you smell?
Where does the water gather and where does it flow?

Slowly bring students back from their visioning and tell them that they should now write about their rain storm. They should use descriptive adjectives to express the details of their storm. Their writing might be in the form of a short story, poem, or even a news report – the point is to be creative and to try to help the reader *feel* the storm.

EXTENSIONS:

Students research significant weather events in history and, being guided by a teacher-devised rubric, act out and record a mock weather newscast report about the event. Integrate multiple facets, such as satellite imagery, ground imagery, basic statistics (i.e., wind speed, rainfall, etc.), human and environmental impact, monetary recovery, etc.

The Water Cycle

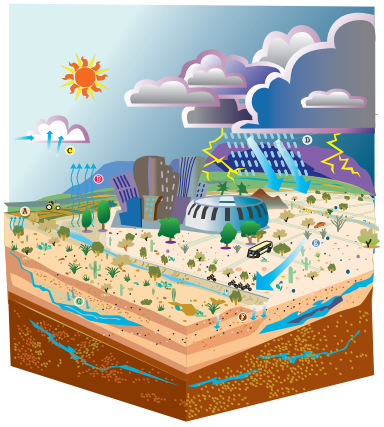
Activity Book, pages 6-8

KEY CONCEPTS:
The water cycle is the continual circulation of water from the earth to the atmosphere and back through such processes as evaporation, condensation, precipitation, and runoff. Water moves through this cycle in the forms of gas, liquid, and solid states.

When rainwater hits the ground it becomes stormwater, flowing downhill towards washes and rivers.

CORRELATED ADE STANDARDS:
Science: SC06-S1C1-02, SC06-S1C2-03, SC06-S1C2-05, SC06-S1C3-02, SC06-S1C3-06, SC06-S2C2-03, SC06-S6C2-01, SC07-S1C1-01, SC07-S1C2-03, SC07-S1C2-05, SC07-S1C3-03, SC07-S1C3-05, SC07-S1C3-07, SC07-S2C2-03, SC08-S1C1-01, SC08-S1C1-03, SC08-S1C2-03, SC08-S1C2-05
ELA: 6.SL.1, 6.SL.2, 6.W.7, 7.SL.1, 7.SL.2, 8.SL.1, 8.SL.2 *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*
Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

ACTIVITY **Test Your Water Cycle Knowledge (pages 6-7)**

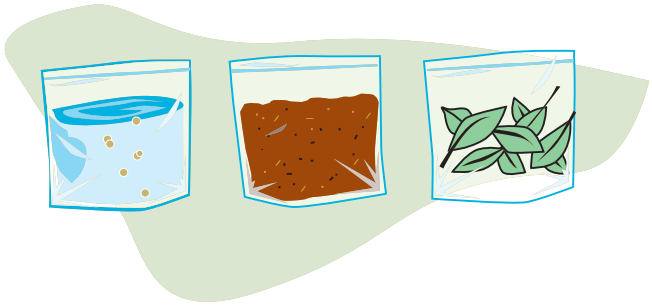


MATERIALS: None

SUGGESTED PROCEDURES:
Students use the text and glossary to determine the correct vocabulary words for a list of definitions describing water cycle processes. Next, they identify the processes that are occurring throughout the water cycle over a graphic of Phoenix.

EXTENSIONS:
Students write a characterization narrative from the view point of a water droplet as it travels through the environment. Challenge your students' droplet characters to all have a slightly different journey! (from the CAP/SRP *Arizona Water Story* teacher workshop)

TRY THIS Water Cycle in a Bag! (page 8)



MATERIALS:

- Sealable plastic bags
- Soil
- Fresh leaves
- Water
- Strong tape
- Window to the outdoors that receives partial to full sun
- *Water Cycle in a Bag - Student Data Shee*t (below)

SUGGESTED PROCEDURES:

Before conducting this activity, be sure your students have read *The Water Cycle* in the activity book and have completed *Test Your Water Cycle Knowledge* (pages 6 and 7). Review the water cycle with the class as you go over the answers on page 7.

This activity may be conducted as: 1) a class demonstration (with one set of bags set up by the teacher); 2) as a student activity (in which students work alone or in teams to prepare and place their own bags); or 3) as a homework assignment.

Hand out copies of the *Water Cycle in a Bag - Student Data Sheet*, either to individuals or teams of students.

Prepare the bags as described on page 8 of the activity book. Be sure that the bags are hung in windows that receive some sunlight. Have students write their predictions on their data sheets. They should make and record daily observations for a week and then complete their data sheets.

The processes of the water cycle demonstrated in this activity are evaporation, condensation, precipitation, and (in the bag with the leaves) transpiration. Each bag will show condensation on the sides of the bags in about a day. As the condensation builds up, the droplets get larger and they eventually run down the sides of the bag (precipitation). The leaves transpire water, the water in the soil evaporates, and water evaporates from the bag of water. The process continually repeats itself – a ''water cycle in a bag!''

NOTE: Although subtle, the water cycle processes are readily observed in each of these bags. The observable processes are actually very similar in each bag – students will likely not notice much of a difference between them. The point of including bags with soil and leaves is to demonstrate that both plants and soil contain water and are a part of the water cycle.

EXTENSIONS:

Add some variables to this experiment: teams of students can collect soil from different places, collect different kinds of leaves, or place their bags in different locations.

Water Cycle in a Bag

Student Data Sheet (page 1)

Name _____ **Class** _____

Prepare your bags according to the instructions on page 8 of the activity book. It is best to put your bags in a location that receives some sun. What do you think will happen? Develop a hypothesis and describe it below. Make daily observations of your bags for at least a week and record your observations. At the end of a week, complete the rest of this data sheet.

1. Hypothesis:
From what you know about the water cycle, what do you think will happen in each of the bags?

2. Describe your daily observations in the table below:

Day	Observations

3. What processes of the water cycle do you observe in this activity?

4. What processes do you know occurred but didn't actually see happen?

5. Were there any differences between the three bags? Explain.

Water Cycle in a Bag

Student Data Sheet (page 2)

Name _____ **Class** _____

6. What were the similarities between the bags?

7. Where is water held in the soil?

8. How does water escape from the leaves?

9. Was your hypothesis correct? Explain.

10. After viewing the results, what new questions do you have or would like to explore?

11. Why do you think this activity is called "Water Cycle in a Bag?"

12. On the back of this page, make labeled drawings of your three bags.

Know Your Watershed

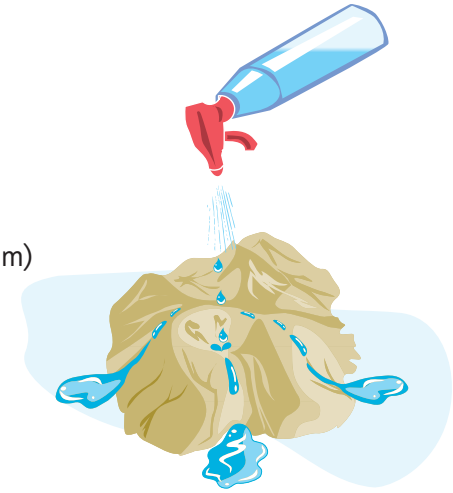
Activity Book, pages 9-15

KEY CONCEPTS:
The total land area that contributes water to a particular drainage channel (wash, arroyo, or stream) is called its watershed. Central Arizona is part of the Salt River Watershed within the White Mountains northeast of Phoenix.

Melting winter snowpack flows downhill towards Phoenix and its surrounding cities. The incoming water is then diverted into canals that direct it to the cities to meet residents' water needs. Conditions that affect the land surface in the watershed impact both the quality and quantity of water flowing from the watershed or infiltrating the ground along the way.

CORRELATED ADE STANDARDS:
Science: SC06-S1C4-05, SC06-S4C3-02, SC06-S6C2-01, SC07-S1C4-05, SC08-S1C3-02, SC08-S1C4-05
Social Studies: SS06-S4C1-03, SS06-S4C2-01, SS06-S4C2-02, SS06-S4C5-02, SS06-S4C5-03, SS07-S4C1-03, SS07-S4C2-01, SS07-S4C5-01, SS07-S4C5-03, SS07-S4C5-04, SS07-S4C5-05, SS08-S4C1-03, SS08-S4C5-01, SS08-S4C5-03
ELA: *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*
Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

TRY THIS **Build a Watershed (page 10)**



MATERIALS:
- Cookie sheets OR aluminum foil pans (8''x 8'' or larger, 1 per student or team)
- Sheets of heavy cardstock (2-3 per student or team) OR wax paper
- Water-filled spray bottle (1 per student or team)
- Tempera paint
- Towels or sponges for water clean-up

SUGGESTED PROCEDURES:
This activity allows students to experience how topography influences the downward movement of water. By building a ''watershed'' and ''raining'' water onto it, students see how water flows off ridges and down separate and distinct watersheds.

The activity may be done as a teacher demonstration if time and materials are limited. However, the concepts are best conveyed if students construct and rain on their own watersheds.

Have students work alone or in teams and follow the ''Build a Watershed'' directions on page 10 of their activity books. Encourage students to create realistic mountains and valleys. If time, consider having them research and recreate the general topography of the mountains that make up the Salt River Watershed.

Once their watersheds are ready, students squeeze a generous amount of tempera paint along the topmost ridgeline of their mountains. Then, they ''make it rain'' over the mountains as evenly as possible using the spray bottle. Give them time to experiment with their rainstorms. Have them consider the following questions with their experiments:

Can you see how your mountain ''sheds'' water?
Where is the water flowing? Along the high or low points on the slope?
How many watersheds did you create?
Does water run off some watersheds more quickly than others?
If so, what influences how fast the water flows?
Can you outline the different watersheds by following the ridgelines?
Do you think this is similar to what happens when it rains on our local mountains?

Have students assist in clean up. Afterwards, discuss:

We cleaned up our runoff water with towels and sponges.
What do you think happens when runoff from the Salt River Watershed flows towards Phoenix?

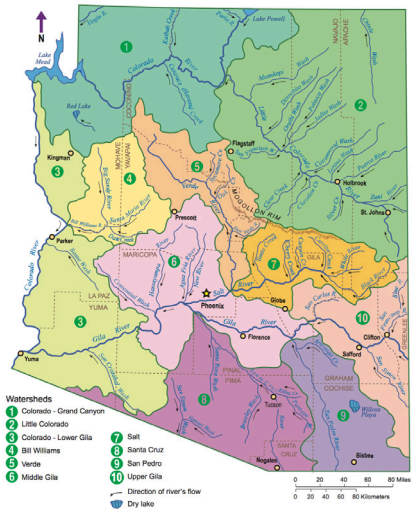
EXTENSIONS:

In lieu of a single ''mountain'', have students construct multiple mountains, connecting each with masking or clear tape along the ''valleys''. This will keep the mountains secure. Repeat the process and share observations. Identify the valleys and the formation of a river. How would students modify their original observations with the single mountain?

Challenge students to create more complex and functional watershed models! Provide teams of students with guidelines for topographical features they must build into their model to eventually test and demonstrate to the class. Such features may include: minimum and maximum mountain heights; a quantity of mountains to build; a variety of slopes, mesas, boulders, sand or dirt, trees, grass; etc. Have students make predictions as to how these features affect water flow; test, make observations, and demonstrate to the class. Students should provide the class with a review of their features and where the water flowed. What did they predict correctly? What did NOT match their predictions? What design features could be engineered differently?

Introduce the concept of erosion using an aluminum pan, sand, dirt, gravel, and a water-filled spray bottle! Visit the Colorado Department of Public Health and Environment's stormwater lesson plan at https://www.colorado.gov/pacific/sites/default/files/WQ_Teacher-Resources.pdf (page II.2). Pollution concepts can be introduced using food colors.

Mapping the Watershed (pages 11-14)



MATERIALS:

- Colored pencils: red, green, blue, orange, purple

SUGGESTED PROCEDURES:

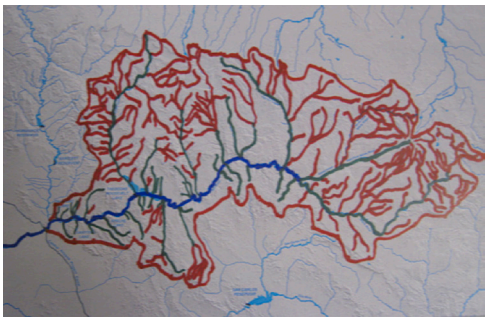
Using the *Arizona's Watersheds* colored map on page 11 and provided key in the activity book, discuss with students the following:

- Definition of a watershed (*total land area that drains precipitation towards a low point, such as a river, wash, or stream*)
- The number (10) and location of Arizona's watersheds *(all 10 watersheds are defined by color on the map and listed in the key)*
- Location of rivers and direction of flow *(refer to each river's arrows that indicate direction of flow)*
- Location of Phoenix *(starred)*
- Location of the Salt River and its direction of flow *(extending eastward from Phoenix; flows from the White Mountains downhill and to the west)*
- Where the Salt River originates and the name of its watershed *(originates at the confluence of the White and Black rivers in eastern Arizona; Salt River Watershed)*
- Location of the Mogollon Rim and summer monsoon moisture accumulating over it (*the Mogollon Rim forms the northern boundaries of the Verde and Salt River watersheds; flows downhill towards Phoenix)*
- Where do the monsoon rains flow to? *(northward into the Little Colorado Watershed, and southward into the Verde, Salt River, and Middle Gila watersheds)*

Before mapping the watershed (pages 12-13), it is highly recommended that the teacher construct a full sample of this exercise to display at the end of the mapping exercise.

Reproduce (scanning or photocopying) the map on page 12 of the student activity book. It has been formatted for best printing quality, but you may have to adjust your computer's or printer's settings for best output.

Using the map on page 12 and directions on page 13, have students map the Salt River Watershed. Allow ample time for students to follow each step. By the end of the exercise, the watershed map should appear similar to this:



Continue the mapping exercise by discussing together (or prompting students to discover individually or in teams) the in-depth questions on page 14 of the activity book. Have students refer to the *Arizona's Watersheds* map on page 11 and their Salt River Watershed map from page 12.

EXTENSIONS:

Further explore the statement, ''Wherever you live, you live in a watershed.'' Using what students have learned from the watershed activities, compare Arizona's topography and resulting watersheds to other various regions of the United States. What types of topography are represented across the country (i.e., flat plains, rocky mountains, hills, mesas, etc.)? Discuss watershed function in these areas and if desired, provide opportunity for students to research and present their conclusions to the class.

In addition to the larger natural landforms, watersheds exist on smaller levels as well, such as rooftops, playgrounds, streets, home patio areas, parking lots, and city drainage structures. Observe one or more of these structures with the class and discuss where water would flow. How does basic watershed science function the same on these micro-levels compared to the larger natural landscapes? How do they differ?

ACTIVITY

Stormwater Cross Word Search (page 15)

MATERIALS: None

SUGGESTED PROCEDURES:

Students use crossword clues and the glossary to complete a crossword puzzle within a word search. Next, they search for stormwater-related words hidden in the word search.

EXTENSIONS:

Have students create a ''Jeopardy''-type game using the key vocabulary terms from the *Stormwater Cross Word Search*. Conduct a ''game day'' for students to rotate around the class to play the games.

C	J	B	Y	1					G	U	L	F	O	F	C	A	L	I	F	O	R	N	I	A
S	P	D	D		G	P	O	O	P	J	R	S	V	O	K	R	R	D	W	Q	B	J	G	O
A	A	2				K	D	X	3	U	D	D	L	E	S	W	E	P	T	A	W	A	Y	G
S	C	R	H		J	R	W	B		T	4	U	M	M	E	R	M	V	W	O	H	G	Q	K
C	I	Q	M	5			6								S	Z	I	W	I	P	N	C	W	J
E	F	Q	A		A	I		B		S		S	B	K	E	H	C	E	G	R	D	K	Q	G
R	I	Q	B		C	N		D		W		B	7	L	O	W	R	G	A	V	T	K	A	T
D	C	8	W		H	G		C		B		K		R	W	Q	O	D	Z	M	O	L	Q	R
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W	C		S		M	U		S	10						11							N	L	S
L	E		L		I	G		T		K		B		G		A	S	Y	N		T	D	W	E
E	A		E		C	E		W	S	V		A		W		I	I	U	J		S	S	T	D
C	N		N	Q	A	D	E	D	D	G		T		G		N	N	W	Q		D	C	J	N
C	Y		N	T	L	M	I	B	C	F		E		A		A	S	B	I		V	A	X	A
V	C		A	R	S	U	S	G	K	H		L		I		G	T	L	S		W	P	12	R
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O	T	W	R	D	F	T	G	S	U	R		A	C	E	15									
E	T	W	T	U	H	E	D	C	S	T	G	Q	K	L		T	C		S	D	S	R		A
N	U	16															E		D	Q	T	G		K
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F	E	H	T	N	K	W	S	A	G	T	W	Q	C	B	P	I	R		Y	T	E	N	L	G

When Water Comes to Town – What Happens?

Activity Book, pages 16-20

KEY CONCEPTS:

Rainwater that falls onto the ground either soaks into the ground or flows away downhill as runoff.

Pervious surfaces soak up rainwater and reduce stormwater runoff. The majority of natural ground surfaces are pervious. Most of the stormwater soaks into the ground and nourishes desert vegetation.

Impervious surfaces shed water and cause it to run off. In cities, impervious surfaces include streets, parking lots, and rooftops. Impervious surfaces contribute to flooding.

CORRELATED ADE STANDARDS:

Science: SC06-S1C1-02, SC06-S1C2-03, SC06-S1C2-05, SC06-S1C3-01, SC06-S2C2-03, SC07-S1C1-01, SC07-S1C2-03, SC07-S1C2-05, SC07-S1C3-01, SC07-S1C3-05, SC07-S2C2-03, SC08-S1C1-01, SC08-S1C1-03, SC08-S1C2-03, SC08-S1C2-05, SC08-S1C3-01, SC08-S1C4-05, SC08-S2C2-01, SC08-S3C2-01

Math: 6.NS.B.2, 6.NS.B.3, 6.RP.A.2, 6.RP.A.3.c, 6.RP.A.3.d, 7.NS.A.2, 7.RP.A.1, 7.G.A.1

ELA: *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*

Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

ACTIVITY Calculating Runoff (pages 17-19)

$$V = A \times R \times Cw$$

MATERIALS:

- Ruler
- Pencil
- Calculator
- *"What is the Runoff Coefficient?"* student worksheet, if needed

SUGGESTED PROCEDURES:

Review the activity as a class to be sure students understand the different variables in the formula for figuring out the amount of runoff from a particular area (surface area, rainfall amount, and the runoff coefficient). Specifically, it is suggested that you review *What is the Runoff Coefficient*? on page 18 with students. For students requiring assistance with math, you may want to have the entire activity be teacher-guided.

Students may work in their activity books, or scroll down and reproduce the *What is the Runoff Coefficient?* worksheets provided.

EXTENSIONS:

Test a variety of materials for pervious and impervious ratings. Brainstorm with students the variety of surfaces they observe in daily life, such as pavement, grass, rooftops, gravel, etc. Collect samples and replications of these materials and lay each out on a table or collection of desks. Experiment and test each material by dropping simulated ''raindrops'' and have students measure splash height. Students should record these measurements and the data on a visual organizer (i.e., line graph, etc.). Discuss the findings and sort the materials in order of porosity. Categorize each material as pervious or impervious.

Map your school with a campus site inventory! Explore the *Urban Runoff* lesson from The Nature Conservancy at https://www.natureworkseverywhere.org/resources/. Students work in teams to measure features of the school campus and map to scale on drafting/grid paper, denoting land and man-made features with designated symbols. Rainfall drainage patterns are discussed, and students can calculate runoff and brainstorm alternate solutions.

What is the Runoff Coefficient?

Student Worksheet

Name _____ **Class** _____

What is the Runoff Coefficient?

The amount of water that will run off a particular surface differs depending on the surface. Pervious surfaces soak up rainwater. Impervious surfaces shed rainwater. To take this effect into consideration when calculating runoff volumes, a runoff coefficient (Cw) is used. The runoff coefficient tells us what proportion of the rainfall will run off from a specific surface. A higher runoff coefficient represents a less pervious and more "slick" surface. Some runoff coefficients are listed below:

soccer field: Cw = 0.17 (This relatively low runoff coefficient indicates a fairly pervious surface which will allow a lot of infiltration.)

gravel: Cw = 0.65 (Bare ground usually has a mid-range value.)

asphalt: Cw = 0.9 (These relatively high runoff coefficients indicate very impervious surfaces which will shed 90% of the water.)

rooftop: Cw = 0.9

The formula for figuring out how much runoff will come from a particular area is:

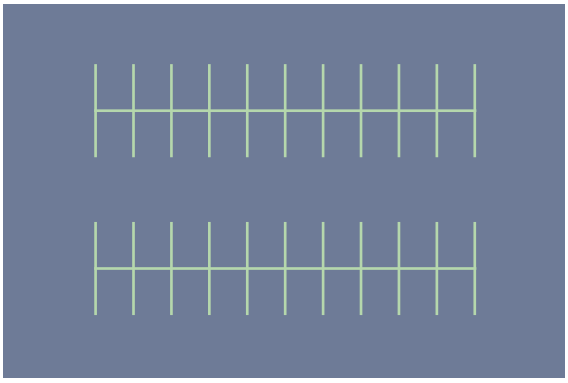
$$V = A \times R \times Cw$$

Where:
V = runoff volume
A = area
R = rainfall amount (in gallons per square foot)
Cw = runoff coefficient

Note: To convert inches of rainfall to gallons per square foot, multiply the amount in inches by 0.623 (gal/ft^2) /inch.

Directions: the diagram below represents an **asphalt parking lot** at your school. How much water runs off of this area during the month of June in an average year?

Scale: 1" = 30'



1. **Use a ruler to measure sides of the space in the diagram.**

Length = _____ inches Width = _____ inches

2. Calculate the actual size using the scale provided.

Length = _____ inches Width = _____ inches

3. Calculate surface area of the space (A) using the formula A = L x W. (Remember your units!)

_____ = _____ x _____
(area) (length) (width)

A = _____ ft^2

4. Use the rainfall table to determine the rainfall amount in inches. June rainfall = _____ inches

5. Convert the rainfall amount (R) from inches to gallons per square foot (gal/ft^2)/inch.

_____ inches x 0.623 (gal/ft^2)/inch = _____ gal/ft^2

R = _____ gal/ft^2

6. Select runoff coefficient (Cw) for this surface. Cw = _____

7. Use the formula V = A x R x Cw to calculate the volume (V) of runoff.

_____ = _____ x _____ x _____
V A R Cw

V = _____ gal

8. Now suppose this same space is a soccer field. Repeat the steps above to calculate the amount of runoff (V) from this area during the month of June in an average year.

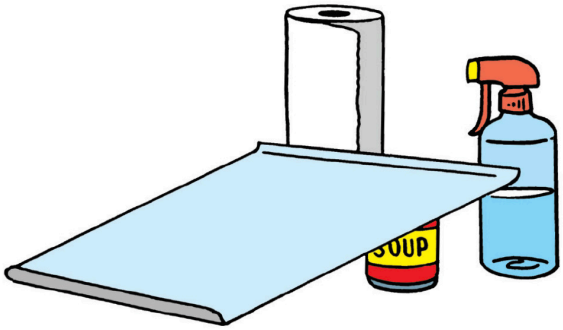
_____ = _____ x _____ x _____
V A R Cw

V = _____ gal

9. Which variable do you have to change and why? _____

10. Is there more runoff from a soccer field or a parking lot? _____

TRY THIS **Raindrop Races (page 19)**



MATERIALS:

- Cookie sheet/s
- Soup (or other) can
- Paper towels
- Tape
- Water-filled spray bottle
- *Raindrop Races - Student Data Sheet* (below)

SUGGESTED PROCEDURES:

This activity involves students in hands-on trials testing how water moves over different surfaces. It demonstrates how different surfaces shed water faster or slower – and therefore have different runoff coefficients.

Before conducting this experiment, be sure students have read *When Water Comes to Town – What Happens?* on pages 16 and 17 of their activity books. Review the reading with students to be sure they understand the differences between pervious and impervious surfaces.

Follow the activity directions for set up. (*NOTE: Be sure that the chosen surfaces will not be damaged by water. It may be best to set up this experiment outside where spills will not be a problem.)*

The race course surfaces will need to be propped up on a soup (or other) can to create an incline of around 45° and should be long enough to allow a drop to run at least 12'' down. Each course should have the same incline.

EXTENSIONS:

Retrace the flow of stormwater backwards, from emptying into an ocean or dry river bed, through residential use, the city treatment plant, upstream along the Salt River, ascending up the watershed mountain/s, and through the water cycle.

Raindrop Races

Student Data Sheet

Name _____ **Class** _____

Before conducting this activity, read pages 16 and 17 of your activity book where *Raindrop Races* is described. Make your predictions, then start your races! When you are done, answer the questions at the end of this sheet.

1. **Describe the two types of surfaces being tested.**

2. **What material represents the pervious side?**

3. **What material represents the impervious side?**

4. **Write your prediction as to which surface will allow the water to flow faster. Why do you think this?**

5. **Race Results! Describe what happened. Did this outcome differ from your prediction? If so, how?**

6. **What happened to the water that was dropped onto the surface that did not shed water quickly? What caused this action?**

7. **Do pervious or impervious surfaces make better race courses? Explain.**

8. **Do surfaces that make better race courses have a higher or lower runoff coefficient? Explain.**

TRY THIS

Raindrop Races Extension – Twinkie Trials (page 19)

MATERIALS:

- Eye droppers
- *Twinkie Trials – Student Data Sheet* (below)
- Kool-Aid or other colorful kid's beverage
- Snack foods such as Twinkies, marshmallows, fruit roll-ups, real fruit (with and without the peel), potato chips, crackers, etc.

SUGGESTED PROCEDURES:

This activity is a fun extension of *Raindrop Races*. This time, water is mixed with a colorful kid's beverage (for visibility) and, using eye droppers, is dropped onto different snack foods. The experiment illustrates the concepts of pervious and impervious surfaces, and is presented as a fun way for students to test their predictions and eat the results! A data sheet is provided for students to record their predictions and observations. *(NOTE: Be mindful of any food allergies amongst the class, and ask parents' permissions before allowing students to eat their "results".)*

Twinkie Trials

Student Data Sheet

Name _____ **Class** _____

Twinkie Trials is described on page 19 of your activity book. Here, you will drop a colored beverage on different snack food surfaces to see if it soaks in or splashes. Make and test your predictions as to what will happen on different surfaces. Complete the table below as you conduct these experiments, then answer the questions at the bottom of this page. Ask your teacher if you can eat the results!

Type of snack food surface:	Prediction: Will your drop soak or splash?	What happened when you dropped water on this snack food surface?	Would you describe this snack food surface as pervious or impervious?

1. **Describe the snack food surfaces on which drops tend to splash.**

2. **Describe the snack food surfaces which tend to soak up liquid.**

3. **What happened when you dropped your beverage on the peel of the fruit?**

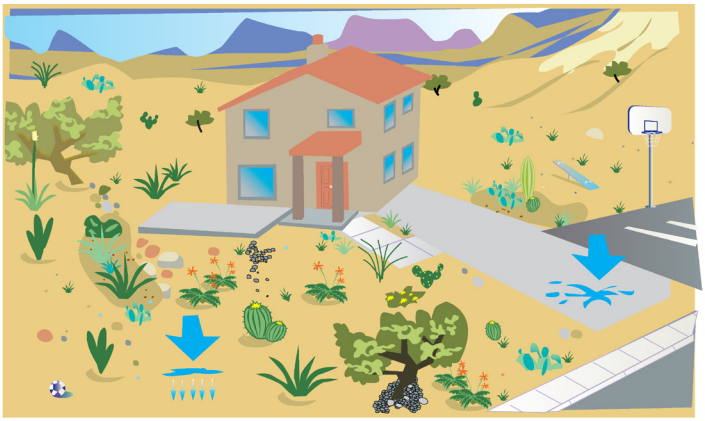
4. **What happened when you dropped your beverage on the fruit without the peel?**

5. **What does this experiment tell you about the role of peel on a fruit?**

6. **What other foods might you test?**

ACTIVITY

Central Arizona Homes – Pervious and Impervious Surfaces (page 20)



MATERIALS: None

SUGGESTED PROCEDURES:
Students study an illustration of a Central Arizona home and determine which surfaces are pervious or impervious. They then choose three impervious surfaces and design a pervious alternative for each.

EXTENSIONS:
As a class, measure your school's outdoor basketball court (or other fixed, impervious structure) and calculate the total area (or square footage). Have students use the Internet to research alternate pervious paving and hardscape surfaces. Calculate the current runoff and cost, and compare to the potential cost and water savings using the alternate pervious surface options.

Explore the question, ''Where does runoff go when it leaves our school campus?'' Connect with the water cycle.

When Water Comes to Town – Where does it go?

Activity Book, pages 21-23

KEY CONCEPTS:
Stormwater falling in Central Arizona must be channeled and drained to washes to reduce flooding. Central Arizona cities have two types of drainage systems: wastewater and stormwater. The wastewater system carries household wastewater to treatment plants to be cleaned and reused for irrigation.

Stormwater is discharged from streets and washes directly to desert streams through a series of gutters, streets, culverts, and underground storm drains. This is the stormwater system. Stormwater is not sent to a treatment plans for reuse, but instead empties directly into washes and rivers.

Therefore, stormwater management is essential in Central Arizona.

CORRELATED ADE STANDARDS:
Science: SC06-S3C1-02, SC06-S4C3-02, SC07-S3C1-01
ELA: *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*
Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

ACTIVITY **Our Amazing Stormwater System (pages 22-23)**

MATERIALS: None

SUGGESTED PROCEDURES:
Students find their way through a maze depicting how stormwater is conveyed throughout a city.

Stormwater Management Structures

Student Worksheet

Name _____ **Class** _____

Directions: Use this worksheet as a guide to locate and identify stormwater management structures around your school campus or neighborhood. In the provided spaces, predict how each structure functions in diverting water to the storm drain system.

STREET

Located? **YES** **NO**

Function prediction: _____

_____

Metal *SCUPPER*

Located? **YES** **NO**

Function prediction: _____

_____

Concrete *SCUPPER*

Located? **YES** **NO**

Function prediction: _____

_____

Curbside *CATCH BASIN*

Located? **YES** **NO**

Function prediction: _____

_____

Parking lot *CATCH BASIN*

Located? **YES** **NO**

Function prediction: _____

_____

Retention *DRYWELL*

Located? **YES** **NO**

Function prediction: _____

_____

Retention *CATCH BASIN*

Located? **YES** **NO**

Function prediction: _____

_____

RETENTION BASIN

Located? **YES** **NO**

Function prediction: _____

_____

Parking lot *DRYWELL*

Located? **YES** **NO**

Function prediction: _____

_____

HEADWALL (2 designs)

Located? **YES** **NO**

Function prediction: _____

_____

EXTENSIONS:

Embark on a local field trip to acquaint students with their school neighborhood and its stormwater management components, specifically the culverts, storm drains, and washes that channel stormwater.

Before going outdoors, print or photocopy the *Stormwater Management Structures* worksheet (below) for each student or team. Briefly review the names and features of each structure and explain that this worksheet will serve as a guide to locate and identify structures and their purposes for managing stormwater. *(NOTE: Not all structures may be present around the school campus. Consider previewing the neighborhood yourself before taking students outdoors.)*

Explain to the students that you will be ''reading the landscape'' to observe and track where water goes. Ask students the following questions to get them prepared for their outing and to guide their observations once they are outdoors:

What are some things we can look for to tell us where water flows in our neighborhood?

How can we tell which way is downhill?

Are there some places where the water soaks in more than others?

Once water enters a drain in our neighborhood, where does it go?

What are some clues that tell us where water goes from here?

Once outdoors, help students look for and notice the following: storm drains, gutters, washes, mud cracks, culverts, *Only Rain in the Drain* markers (if available), debris left behind after a flow event, puddles or water marks from salt or other staining left from old puddles, slight changes in elevation, pervious and impervious surfaces, denser vegetation growth indicating a watercourse, and any other signs of water they might observe. Have students notice the slope of streets and imagine how water flows from higher areas to lower. You could make it a contest to see who devises the most observations.

Keep Our Stormwater Clean!

Activity Book, pages 24-27

KEY CONCEPTS:
As runoff flows over different surfaces, pollutants are picked up and carried to our washes.

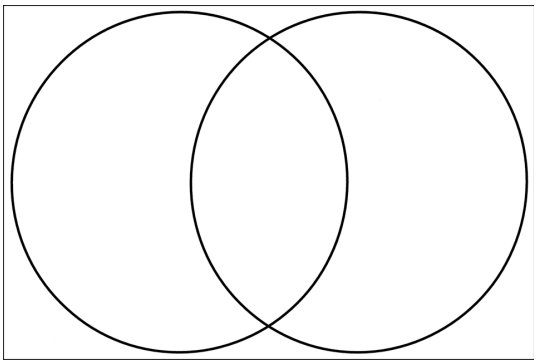
The greater the volume of runoff, the more pollutants are carried to our storm drains and washes. Stormwater pollution can harm plants and wildlife, is unsightly, and can percolate down to the groundwater aquifer – our source of drinking water.

CORRELATED ADE STANDARDS:
Science: SC06-S1C1-02, SC06-S1C2-05, SC06-S1C3-01, SC06-S1C3-02, SC06-S1C3-03, SC06-S1C3-06, SC06-S1C4-05, SC06-S2C2-03, SC06-S3C2-02, SS07-S1C1-01, SC07-S1C2-05, SC07-S1C3-01, SC07-S1C3-02, SC07-S1C3-07, SC07-S2C2-03, SC07-S3C1-01, SC07-S3C1-03, SC07-S3C2-01, SC07-S3C2-02, SS08-S1C1-01, SC08-S1C2-05, SC08-S1C3-01, SC08-S1C3-02, SC08-S2C2-01, SC8-S3C1-01, SC08-S3C2-01, SC08-S3C2-02
Social Studies: SS06-S3C4-01, SS07-S3C4-01
ELA: 6.SL.1, 6.SL.4, 6.SL.5, 7.SL.1, 7.SL.4, 7.SL.5, 8.SL.1, 8.SL.4, 8.SL.5 *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*
Educational Technology: ET06-S1C1-01, ET06-S1C4-01, ET06-S1C4-02, ET06-S2C2-01, ET06-S3C2-02, ET06-S3C2-04, ET06-S6C1-03, ET06-S6C2-05, ET07-S1C1-01, ET07-S1C4-01, ET07-S1C4-02, ET07-S2C1-01, ET07-S2C2-01, ET07-S3C2-02, ET07-S3C2-04, ET07-S6C1-03, ET07-S6C2-05, ET08-S1C1-01, ET08-S1C4-01, ET08-S1C4-02, ET08-S2C1-01, ET08-S2C2-01, ET08-S3C2-02, ET08-S3C2-04

ACTIVITY Pollutant Identification Exercise (page 24)

MATERIALS: None

SUGGESTED PROCEDURES:
Students sort a list of pollutants by their source/s: household and residential; commercial and industrial; or both. Students consider which of these pollutants they can personally help to reduce.



ACTIVITY

Can You Reverse Pollution? (page 25)

MATERIALS:

- Plastic bucket or dishpan filled with clean water
- Wooden spoon
- Used household trash items (i.e., paper, plastic wrap, banana peel, pencil shavings, aluminum foil, Styrofoam)
- Cooking oil or motor oil (with permission)
- Handful of flour
- Soil or dirt
- Rocks
- Kitchen tongs and strainer
- Other miscellaneous tools

SUGGESTED PROCEDURES:

This activity may be conducted in teams in the classroom, or as a supervised homework assignment.

Follow the directions on page 25, emphasizing the representations of the items being used and real environmental pollutants (such as trash, toxic chemicals, sediments, etc.). Have students record their procedures, results, and further questions in a science notebook.

Once all items have been added to the bucket or dishpan and "swirled" around, allow students to attempt the clean up! Students may use kitchen tongs and strainers, and are encouraged to brainstorm alternate tools as they move through the experiment.

Conduct a discussion in which teams share and compare their results. What hypotheses does the experiment lead them to? What are some viable solutions that could address this particular pollution problem?

EXTENSIONS:

Focus on oceanic clean up after an oil spill. Learn about fossil fuels (particularly petroleum), define an oil spill, examine side effects, and create a natural model habitat. Mimic an oil spill and test different methods to clean up their habitats. Download the lesson plan from California Academy of Sciences at https://www.calacademy.org/educators/lesson-plans/slippery-shores-oil-spill-clean-up.

Now that students are familiar with the variety of pollutants in our stormwater and the challenges of reversing pollution, engage students to co-plan a school-wide clean up! Engage in a class discussion about the importance of keeping our environment (including oceans) clean and minimally polluted. What role does an individual play? A community? A city? The global population as a whole? Plan, make posters for, advertise around campus, and conduct a school-wide clean-up day. Ask parents to volunteer in this effort. Visit Learning to Give at https://www.learningtogive.org/units/earth-keepers/great-school-clean for steps and tips.

Follow that pollutant! Write and illustrate (or record a movie or "selfie" collage) about a pollutant traveling from the watershed to its final drainage point (past the city and into a river or ocean). Tell the story in first person and include key points and vocabulary. Expand on environmental hazards encountered and consequences along the journey.

In teams or individually, have students research pieces of data and history, collect photos, and document Phoenix-area land use from 20, 50, and even 100 years ago to today (such as physical land use, population, demand on natural resources, urban materials, energy usage, pollution, climate change, growing environmental issues, etc.). Make connections with changes in water quality, climate, population density, smog, energy/utility costs, etc.

TRY THIS Get Proactive in Preventing Pollution! (page 26)

MATERIALS: Varied

SUGGESTED PROCEDURES:
Review the five activity suggestions for students: *Act It!, Create It!, Adopt It!, Design It!*, and *Pitch It!* Consider adopting one or more of these initiatives with your class/es. Encourage students to incorporate multiple aspects of multimedia (such as narration, imagery, color, music, special effects, etc.) into their projects. What other elements could be added to strengthen the messages?

ACTIVITY Jumbled Pollutants (page 27)

MATERIALS: None

SUGGESTED PROCEDURES:
Students unscramble jumbled words to reveal some pollutants that can be transported by stormwater to our washes. Then, they unscramble the circled letters to discover the secret message *"Only Rain in the Drain!"*.

Safe From the Storm?

Activity Book, pages 28-31

KEY CONCEPTS:
Our normally dry desert washes can be quickly flooded with water during a rainstorm.

The water depth and swiftness of a flowing wash are often greater than they appear. Any culvert, wash or other means of channeling stormwater is not a safe place to play.

A driver can lose control of a car in only one foot of water. Drivers should never enter flowing washes.

CORRELATED ADE STANDARDS:
Science: SC06-S1C3-04, SC06-S3C1-02, S07-S3C1-03, SC08-S3C1-02
Social Studies: SS06-S4C1-03, SS07-S4C1-03, SS08-S4C1-03
ELA: 6.SL.2, 6.SL.3, 7.SL.2, 7.SL.3, 8.SL.2, 8.SL.3 *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*
Health: H6-8-S1C3-01, H6-8-S1C4-01, H6-8-S1C6-02, H6-8-S1C6-03, H6-8-S2C1-03, H6-8-S2C1-05, H6-8-S4C3-01, H6-8-S7C2-02, H6-8-S8C1-01, H6-8-S8C1-02 *(NOTE: Health standards are clustered for grades 6, 7, and 8.)*
Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

TRY THIS **Do the Right Thing (page 31)**

MATERIALS: None

SUGGESTED PROCEDURES:
This *Try This* activity encourages students to spread Lacie's message: "Don't get swept away, find a safer place to play." Lacie expresses her message in a story she wrote specifically for this activity book. In it, she describes a real event in which her brother fell into and was rescued from a flowing wash.

Choose a student to read Lacie's story out loud to the class. Use the following questions to guide a discussion about Lacie's story, message, and "doing the right thing."

How does this story make you feel?

Lacie thought she could help her brother by jumping in, but what happened instead?

What are some things the kids shouldn't have done?

What are some things the kids did right?

What do you think Lacie does now when it rains?

What would you say if you saw some little kids playing in a dry wash? Could you remind them that even if it's dry now, in the rainy season, it could be very dangerous and they should find another place to play?

If you were approaching a flooded wash in a car, what would you tell the driver?

Earth's Water, Conservation and Rainwater Harvesting

Activity Book, pages 32-35

KEY CONCEPTS:

Though 71% of Earth is covered by water, only 3% of the total amount of water exists as freshwater, with merely 1% being accessible and usable by humans. Given Arizona's natural climate and rising population, water conservation is crucial. As one form of conservation, rainwater can be collected and used for human needs. Rainwater harvesting is the capturing, storing, and dispersing of rainwater to provide irrigation water for landscaped plants. Since it is stored locally, there is a reduced need to extract water from underground aquifers.

CORRELATED ADE STANDARDS:

Science: SC06-S1C2-03, SC06-S1C2-04, SC06-S1C2-05, SC06-S1C3-01, SC06-S1C3-02, SC06-S1C3-03, SC06-S1C3-04, SC06-S1C4-02, SC06-S1C4-05, SC06-S2C2-03, SC06-S3C2-02, SC07-S1C2-03, SC07-S1C2-04, SC07-S1C2-05, SC07-S1C3-01, SC07-S1C3-05, SC07-S1C4-02, SC07-S1C4-05, SC07-S2C2-03, SC07-S3C1-01, SC07-S3C1-03, SC08-S1C2-03, SC08-S1C2-04, SC08-S1C2-05, SC08-S1C3-01, SC08-S1C4-01, SC08-S2C2-01, SC08-S3C2-01

Math: 6.RP.A.2, 6.RP.A.3.c

ELA: *(NOTE: Reading Standards for Informational Text [RI] are incorporated throughout each section of* ***STORMWATER IN THE DESERT****.)*

Educational Technology: ET06-S1C1-01, ET06-S3C2-02, ET06-S3C2-04, ET07-S1C1-01, ET07-S3C2-02, ET07-S3C2-04, ET08-S1C1-01, ET08-S3C2-02, ET08-S3C2-04

ACTIVITY Toss n' Tally (page 32)

MATERIALS:

- Inflatable or stuffed earth ball (about 12'' in diameter)
- Whiteboard or scratch paper
- Whiteboard marker, pen, or pencil

SUGGESTED PROCEDURES:

Use math to demonstrate that the Earth is covered mostly with water!

Inflate the earth ball if needed. Gather the class in a circle around the room (or outside, with little to no wind). Choose one student to serve as a recorder, and draw a simple T-chart on a whiteboard or scratch paper. Label the left column ''Land'' and the right column ''Water''.

Give the earth ball to a random student (A) and ask him or her to toss it to another random student (B). Student B catches with both hands and without moving or removing any fingers, counts how many are on land and how many are on water. Report these numbers to the recorder, who then makes tally marks for the land and water values in their respective columns. Student B then tosses the ball to student C, and the process repeats for a total of 100 tosses.

At the conclusion, the recorder calculates the tallies for each category and converts the numbers to percentages. The totals should roughly represent 30% land and 70% water.

ACTIVITY Water Models (page 32)

MATERIALS:

- One 5-gallon bucket
- Standard measuring cups
- Plastic metric syringe
- 5 large cups (such as SOLO party cups)
- Tape
- Black permanent marker
- Nearby water access

SUGGESTED PROCEDURES:

Gather all materials and label the cups as indicated in the activity description.

This activity should be done in large teams or as a whole class. It is suggested the teacher inform the students the purpose of the exercise.

Follow the directions in the activity book, reminding students to measure their water extractions carefully and as exact as possible. Be sure to correctly match the labeled cup (water vapor, soil moisture, rivers/streams/lakes, groundwater, ice caps) with its intended amount of water! As water is removed from the bucket, arrange the cups in a sequential order from greatest amount to least amount left to right on a table or grouping of desks.

When concluded, discuss the following questions with the students:

What has surprised you about Earth's water distribution?

What threats does the water cycle face?

How does ocean pollution affect these water distributions? Toxic chemical leaks? Landfill and waste seepage into the groundwater?

How does this change your thinking about water conservation?

What are some ways that you could conserve water at home or school?

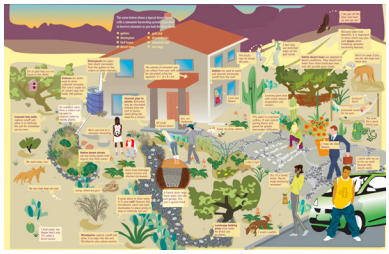
EXTENSIONS:
Ask students to conduct a home water audit! This can be a simple exercise, such as measuring the amount of water it takes to wash hands or brush teeth (both with running water), where students do these over a large measuring cup. Multiply the amount by one day; one week; one year. What is the approximate water usage per year for that individual? Family? What conclusions can be drawn about humans' daily habits and developing conservational awareness?

Take it further! Repeat the same action/s by turning off the water while washing hands or brushing teeth. Re-measure the amounts of water used. Complete the same calculations and then compare to discover the amount of water conserved by changing simple habits! Encourage students to justify their thinking and to share this information with friends and family.

ACTIVITY **Rainwater Harvesting Terms (page 33)**

MATERIALS: None

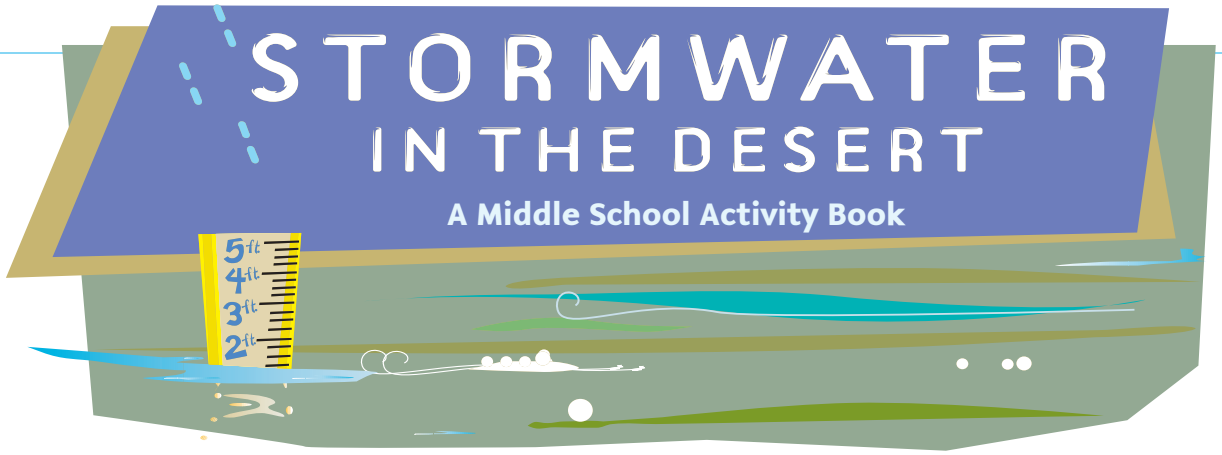
SUGGESTED PROCEDURES:
This is a short exercise for students to review and apply rainwater harvesting vocabulary terms to clues. Answers are provided on page 38 of the activity book.



ACTIVITY **Discover Rainwater Harvesting (pages 34-35)**

MATERIALS: None

SUGGESTED PROCEDURES:
Students learn how to harvest rainwater as they search for specific items on an illustration of a desert home.



WEBSITES, CURRICULA, AND OTHER RESOURCES

Town of Gilbert - Water Education Outreach

https://www.gilbertaz.gov/departments/public-works/water-conservation/school-programs

The Gilbert Water Conservation office provides free educational programming for 4th and 6th grade classes throughout Gilbert, Arizona. Science and math are incorporated to teach children about the importance of water in the desert and how to preserve it.

Arizona Stormwater Outreach for Regional Municipalities

http://www.azstorm.org/

STORM is a regional organization promoting stormwater quality education within the greater Phoenix metropolitan area. STORM uses a multimedia approach targeting audiences through radio, television, special events, and providing permit information to the general public and the regulated community. ***STORMWATER IN THE DESERT*** was developed in partnership with STORM and the Environmental Education Exchange.

Project WET

http://cals.arizona.edu/arizonawet/

Project WET (Water Education for Teachers) provides an opportunity to learn about Arizona's water resources by participating in fun, interactive, classroom-ready activities. The activities, developed and tested by teachers, are designed to develop critical thinking and build an understanding of concepts by experiential learning. Activities cover the properties of water, the water cycle, watersheds, groundwater, water quality, water rights, as well as an understanding of the importance of water to all water users.

Sweetwater Wetlands Activity Book and Field Guide

https://www.tucsonaz.gov/files/water/docs/Sweetwater_Student_Web.pdf

This guide provides information about the water cycle, ecology and conservation, as well as photographic descriptions of the mammals, birds, insects, plants and reptiles that inhabit the Sweetwater Wetlands. Use the link above to download a copy of the book.

Arizona Water Story Teacher Professional Development Workshop

https://www.srpnet.com/education/training.aspx

Salt River Project offers an in-service primer about the desert's most precious resource. Workshop topics include Central Arizona water history, watersheds and water flow, water management concepts, environmental water issues, and water science. Participants will receive water resource materials and lesson plans, a video, and CEU credits.

Salt River Project

https://www.srpnet.com/education/materials.aspx

Salt River Project offers free water educational materials for grades K-12. Topics for middle-high school grades include water science, conservation, hydroelectricity, and water around the community. Books, posters, and a DVD are offered.

Arizona Dept. of Water Resources (ADWR)

http://www.azwater.gov/dwr/

ADWR works to secure long-term dependable water supplies for Arizona's communities. The Department administers and enforces Arizona's groundwater code and surface water rights laws (except those related to water quality); negotiates with external political entities to protect Arizona's Colorado River water supply; oversees the use of surface and groundwater resources under state jurisdiction; and represents Arizona in discussions of water rights with the federal government.

Water - Use It Wisely (WUIW)

https://wateruseitwisely.com/kids/

The Water - Use It Wisely campaign was launched in 1999 to promote an ongoing water conservation ethic among Arizona's rapidly growing population. Following Arizona's lead, nearly 400 municipalities have adopted the WUIW model, making it one of the largest conservation education outreach programs in the world. WUIW offers fun water-focused activities and games, conservation exercises, and up-to-date information on water usage and statistics.

Environmental Protection Agency (EPA) - Water

http://www.epa.gov/water/

This site from the U.S. Environmental Protection Agency (EPA) provides a wealth of information on a variety of water topics. Teachers should be sure to check out the links for ''Education Resources'' and ''Water for Kids''.

National Weather Service

http://www.nws.noaa.gov/

The National Weather Service (NWS) is a component of the National Oceanic and Atmospheric Administration (NOAA). NWS provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy.

University of Arizona Water Resources Research Center

http://ag.arizona.edu/AZWATER/

The University of Arizona's Water Resources Research Center promotes understanding of critical state and regional water management and policy issues through research, community outreach and public education.

Central Arizona Project - H204U

https://www.cap-az.com/education/h204u-6-12

H204U is a program for middle and high school students to learn about the Colorado River, water conservation, water safety, and careers in the water industry. The H204U activities can be used independently or together as a unit. Lessons are provided for grades 6-12.

Salt River Project Watershed Connection

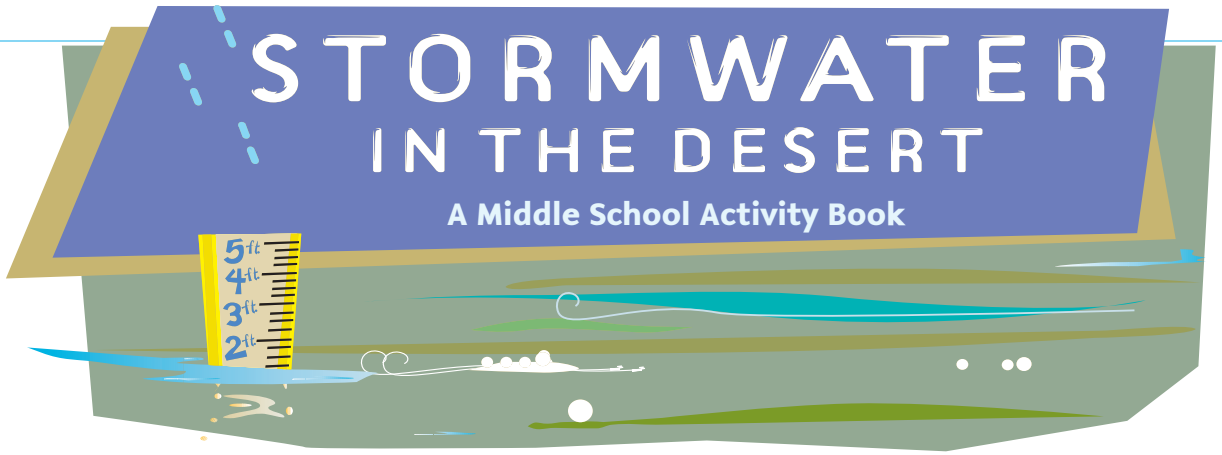
https://www.watershedconnection.com/

SRP's Watershed Connection was launched in 2017. In addition to providing real-time data about hydrological and meteorological conditions, Watershed Connection provides information about important efforts to protect and preserve the watersheds in perpetuity for all water users. Community and water-related events are shared.

Environmental Education Exchange

https://www.eeexchange.org/

The Environmental Education Exchange is an Arizona non-profit organization specializing in the advancement of environmental literacy and application. The Exchange partners with municipalities and organizations across the nation, and develops relevant curricula and outreach presentation programs for over 80,000 students and adults each year. Browse through the Exchange's portfolio and resources at the above link.



ARIZONA DEPARTMENT OF EDUCATION (ADE) STANDARDS

STORMWATER IN THE DESERT: A Middle School Activity Book addresses the following academic standards for Arizona. The degree of applicability for every standard is at the teacher's final discretion. Complete versions of the standards are available at http://www.ade.state.az.us/. Refer to individual codes for their targeted grade levels.

	Stormwater in the Desert?	The Water Cycle	Know Your Watershed	When Water Comes to Town-What Happens?	When Water Comes to Town-Where Does It Go?	Keep Our Stormwater Clean!	Safe From the Storm	Discover Rainwater Harvesting
SCIENCE								
SC06-S1C1-02: Formulate questions based on observations that lead to the development of a hypothesis.		X		X		X		
SC06-S1C2-02: Design an investigation to test individual variables using scientific processes.		X		X		X		X
SC06-S1C2-04: Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).	X							X
SC06-S1C2-05: Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.	X	X		X		X		X
SC06-S1C3-01: Analyze data obtained in a scientific investigation to identify trends.				X		X		X

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SCIENCE								
SC06-S1C3-02: Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).		X				X		X
SC06-S1C3-03: Evaluate the observations and data reported by others.						X		X
SC06-S1C3-04: Interpret simple tables and graphs produced by others.	X						X	X
SC06-S1C3-06: Formulate new questions based on the results of a completed investigation.		X				X		
SC06-S1C4-02: Display data collected from a controlled investigation.								X
SC06-S1C4-05: Communicate the results and conclusion of the investigation.			X			X		X
SC06-S2C2-03: Apply the following scientific processes to other problem solving or decision-making situations: observing, questioning, communicating, comparing, measuring, classifying, predicting, organizing data, inferring, generating hypotheses, identifying variables.		X		X		X		X
SC06-S3C1-02: Describe how people plan for, and respond to, the following natural disasters: drought, flooding, tornadoes.					X		X	

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SCIENCE								
SC06-S3C2-02: Compare possible solutions to best address an identified need or problem.						X		X
SC06-S4C3-02: Describe how the following environmental conditions affect the quality of life: water quality, climate, population density, smog.			X		X			
SC06-S6C2-01: Explain how water is cycled in nature.		X	X					
SC06-S6C2-05: Analyze the impact of large-scale weather systems on the local weather.	X							
SC07-S1C1-01: Formulate questions based on observations that lead to the development of a hypothesis.		X		X		X		
SC07-S1C2-03: Conduct a controlled investigation, utilizing multiple trials, to test a hypothesis using scientific processes.		X		X		X		X
SC07-S1C2-04: Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).	X							X
SC07-S1C2-05: Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.	X	X		X		X		X
SC07-S1C3-01: Analyze data obtained in a scientific investigation to identify trends.				X		X		X

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SCIENCE								
SC07-S1C3-02: Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).						X		
SC07-S1C3-03: Analyze results of data collection in order to accept or reject the hypothesis.		X						
SC07-S1C3-05: Formulate a conclusion based on data analysis.		X		X				X
SC07-S1C3-07: Formulate new questions based on the results of a previous investigation.		X				X		
SC07-S1C4-02: Display data collected from a controlled investigation.								X
SC07-S1C4-05: Communicate the results and conclusion of the investigation.			X					X
SC07-S2C2-03: Apply the following scientific processes to other problem solving or decision-making situations: observing, questioning, communicating, comparing, measuring, classifying, predicting, organizing data, inferring, generating hypotheses, identifying variables.		X		X		X		X

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SCIENCE								
SC07-S3C1-01: Analyze environmental risks (e.g., pollution, destruction of habitat) caused by human interaction with biological or geological systems.					X	X		X
SC07-S3C1-03: Propose possible solutions to address the environmental risks in biological or geological systems.						X	X	X
SC07-S3C2-01: Propose viable methods of responding to an identified need or problem.						X		
SC07-S3C2-02: Compare solutions to best address an identified need or problem.						X		
SC08-S1C1-01: Formulate questions based on observations that lead to the development of a hypothesis.		X		X		X		
SC08-S1C1-03: Generate a hypothesis that can be tested.		X		X		X		
SC08-S1C2-03: Conduct a controlled investigation to support or reject a hypothesis.		X		X		X		X
SC08-S1C2-04: Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers).	X							X
SC08-S1C2-05: Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.	X	X		X		X		X

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SCIENCE								
SC08-S1C3-01: Analyze data obtained in a scientific investigation to identify trends.				X		X		X
SC08-S1C3-02: Form a logical argument about a correlation between variables or sequence of events (e.g., construct a cause-and-effect chain that explains a sequence of events).			X			X		
SC08-S1C4-01: Communicate the results of an investigation.								X
SC08-S1C4-05: Communicate the results and conclusion of the investigation.			X	X				
SC08-S2C2-01: Apply the following scientific processes to other problem solving or decision making situations: observing, questioning, communicating, comparing, measuring, classifying, predicting, organizing data, inferring, generating hypotheses, identifying variables.				X		X		X
SC08-S3C1-01: Analyze the risk factors associated with natural, human induced, and/or biological hazards, including: waste disposal of industrial chemicals, greenhouse gases.						X		
SC08-S3C1-02: Analyze possible solutions to address the environmental risks associated with chemicals and biological systems.							X	
SC08-S3C2-01: Propose viable methods of responding to an identified need or problem.				X		X		X

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SCIENCE								
SC08-S3C2-02: Compare solutions to best address an identified need or problem.						X		
MATH								
6.NS.B.2: Fluently divide multi-digit numbers using a standard algorithm.	X			X				
6.NS.B.3: Fluently add, subtract, multiple, and divide multi-digit decimals using a standard algorithm for each operation.	X			X				
6.RP.A.2: Understand the concept of a unit rate a/b associated with a ratio a:b and b not equal to 0, and use rate language (e.g., for every, for each, for each 1, per) in the context of a ratio relationship.				X				X
6.RP.A.3.c: Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity). Solve percent problems with the unknown in all positions of the equation.				X				X
6.RP.A.3.d: Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.				X				
7.NS.A.2: Multiply and divide integers and other rational numbers.				X				
7.RP.A.1: Compute unit rates associated with ratios involving both simple and complex fractions, including ratios of quantities measured in like or different units.				X				

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MATH								
7.G.A.1: Solve problems involving scale drawings of geometric figures, such as computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.				X				
SOCIAL STUDIES								
SS06-S3C4-01: Describe ways an individual can contribute to a school or community.						X		
SS06-S4C1-03: Interpret maps, charts, and geographic databases using geographic information.	X		X				X	
SS06-S4C1-04: Locate physical and human features (e.g., significant waterways, mountain ranges, cities, countries) in the United States and in regions of the world on a map.	X							
SS06-S4C2-01: Identify regions studied in Strand 2 using a variety of criteria (e.g., climate, landforms, culture, vegetation).	X		X					
SS06-S4C2-02: Describe the factors that cause regions and places to change.			X					
SS06-S4C5-02: Describe the intended and unintended consequences of human modification (e.g., irrigation, aqueducts, canals) on the environment.	X		X					

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SOCIAL STUDIES								
SS06-S4C5-03: Explain how changes in the natural environment (e.g., flooding of the Nile) can increase or diminish its capacity to support human activities.	X		X					
SS07-S3C4-01: Describe the benefits of community service.						X		
SS07-S4C1-03: Interpret maps, charts, and geographic databases using geographic information.	X		X				X	
SS07-S4C1-04: Locate physical and cultural features (e.g., continents, cities, countries, significant waterways, mountain ranges, climate zones, major water bodies, landforms) throughout the world.	X							
SS07-S4C2-01: Describe the human and physical characteristics of places and regions.			X					
SS07-S4C5-01: Identify the physical processes (e.g., conservation of natural resources, mining, water distribution in Arizona) that influence the formation and location of resources.			X					
SS07-S4C5-02: Describe the consequences of natural hazards (e.g., Dust Bowl, hurricanes, droughts, earthquakes).	X							

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SOCIAL STUDIES								
SS07-S4C5-03: Describe how humans modify environments (e.g., conservation, deforestation, dams) and adapt to the environment.	X		X					
SS07-S4C5-04: Describe the positive and negative outcomes of human modification on the environment.			X					
SS07-S4C5-05: Explain how modification in one place (e.g., canals, dams, farming techniques, industrialization) often leads to changes in other locations.	X		X					
SS08-S4C1-03: Interpret maps, charts, and geographic databases using geographic information.	X		X				X	
SS08-S4C1-04: Locate physical and cultural features (e.g., continents, cities, countries, bodies of water, landforms, mountain ranges, climate zones) throughout the world.	X							
SS08-S4C5-01: Describe how (e.g., deforestation, desertification) humans modify ecosystems.			X					
SS08-S4C5-03: Explain how changes in the natural environment can increase or diminish its capacity to support human activities.	X		X					

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ENGLISH LANGUAGE ARTS								
6.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on other's ideas and expressing their own clearly.	X	X				X		
6.SL.2: Interpret information presented in diverse media and formats (e.g., visually, quantitatively, and orally) and explain how it contributes to a topic, text, or issue under study.	X	X					X	
6.SL.3: Delineate a speaker's argument and specify claims, distinguishing claims that are supported by reasons and evidence from claims that are not.							X	
6.SL.4: Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciations.						X		
6.SL.5: Include multimedia components (e.g., graphics, images, music and sound) and visual displays in presentations to clarify information.						X		
6.W.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.	X							

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ENGLISH LANGUAGE ARTS								
6.W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	X							
6.W.7: Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.		X						
7.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on other's ideas and expressing their own clearly.	X	X				X		
7.SL.2: Analyze the main idea and supporting details presented in diverse media and formats (e.g., visually, quantitatively, and orally) and explain how the ideas clarify a topic, text, or issue under study.		X					X	
7.SL.3: Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.							X	
7.SL.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, appropriate vocabulary, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.						X		

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ENGLISH LANGUAGE ARTS								
7.SL.5: Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.		X				X		
7.W.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.	X							
7.W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	X							
8.SL.1 (broad): Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on other's ideas and expressing their own clearly.	X	X				X		
8.SL.2: Analyze the main idea and supporting details presented in diverse media and formats (e.g., visually, quantitatively, and orally) and explain how the ideas clarify a topic, text, or issue under study.		X					X	
8.SL.3: Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.							X	

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ENGLISH LANGUAGE ARTS								
8.SL.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.						X		
8.SL.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.						X		
8.W.3: Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.	X							
8.W.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	X							
HEALTH (all Health standards are grouped as a 6-8 grade cluster; no individual grade distinctions in coding)								
H6-8-S1C6-03: Examine the potential seriousness of injury or illness if engaging in unhealthy behaviors.							X	
H6-8-S2C1-03: Analyze how peers influence healthy and unhealthy behaviors.							X	

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HEALTH (all Health standards are grouped as a 6-8 grade cluster; no individual grade distinctions in coding)								
H6-8-S2C1-05: Analyze how messages from media influence health behaviors.							X	
H6-8-S3C2-01: Access valid health information from home, school, and community.							X	
H6-8-S4C3-01: Identify ways to ask for assistance to enhance the health of self and others.							X	
H6-8-S7C2-02: Demonstrate behaviors that avoid or reduce health risks to self and others.							X	
H6-8-S8C1-01: State a health enhancing position on a topic and support it with accurate information.							X	
H6-8-S8C1-02: Demonstrate how to influence and support others to make positive health choices.							X	
EDUCATIONAL TECHNOLOGY								
ET06-S1C1-01: Analyze information to generate new ideas and products.	X	X	X	X	X	X	X	X
ET06-S1C4-01: Analyze information using digital creativity tools to create original works and express ideas.						X		
ET06-S1C4-02: Use digital collaborative tools to analyze information to produce original works and express ideas.						X		

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EDUCATIONAL TECHNOLOGY								
ET06-S2C2-01: Communicate and collaborate for the purpose of producing original works or solving problems.						X		
ET06-S3C2-02: Use authoritative primary and/or secondary sources.	X	X	X	X	X	X	X	X
ET06-S3C2-04: Use appropriate digital tools to synthesize research information to develop new ideas and/or create new understanding.	X	X	X	X	X	X	X	X
ET06-S6C1-03: Choose technology applications appropriate for the audience and task.						X		
ET06-S6C2-05: Create multimedia presentations with multiple pages, audio, images, and transitions for individual assignments.						X		
ET07-S1C1-01: Analyze and evaluate information to generate new ideas, processes or products.	X	X	X	X	X	X	X	X
ET07-S1C4-01: Create innovative products or projects using digital tools to express original ideas.						X		
ET07-S1C4-02: Use digital tools to synthesize information, produce original works, and express ideas.						X		
ET07-S2C1-01: Collaborate and communicate with peers, experts, or others employing a variety of digital tools to share findings and/or publish.						X		

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EDUCATIONAL TECHNOLOGY								
ET07-S2C2-01: Communicate and collaborate for the purpose of producing original works or solving problems.						X		
ET07-S3C2-02: Use authoritative primary and/or secondary sources.	X	X	X	X	X	X	X	X
ET07-S3C2-04: Synthesize research information to create new understand or develop new ideas.	X	X	X	X	X	X	X	X
ET07-S6C1-03: Choose technology applications appropriate for the audience and task.						X		
ETO7-S6C2-05: Create and edit visual and audio material to generate a multimedia project.						X		
ET08-S1C1-01: Analyze and evaluate information to generate new ideas, processes or products.	X	X	X	X	X	X	X	X
ET08-S1C4-01: Create innovative products or projects using digital tools to express original ideas.						X		
ET08-S1C4-02: Use digital tools to collaborate with a group to communicate original ideas, products, or projects effectively in a creative or innovative style.						X		
ET08-S2C1-01: Collaborate and communicate with peers, experts, or others employing a variety of digital tools to share findings and/or publish.						X		

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EDUCATIONAL TECHNOLOGY								
ET08-S2C2-01: Communicate and collaborate for the purpose of producing original works or solving problems.						X		
ET08-S3C2-02: Evaluate and use authoritative primary and/or secondary sources.	X	X	X	X	X	X	X	X
ET08-S3C2-04: Synthesize research information to create new understanding.	X	X	X	X	X	X	X	X

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A Middle School Activity Book

What fans have to say about ***Stormwater in the Desert...***

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- *Taylor Swift*

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- *Mr. Science*

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