Smart Landscapes

How can you transform your school grounds into a water-efficient oasis?

Grade Level:
7–12

Subject Areas:
Environmental Science, Geography, Social Studies, Life Science, Earth Science, Physical Science, Math, Economics, Fine Arts

Duration:
Preparation time: 90 minutes
Activity time: 4 hours (*Part I:* 1 hour; *Part II:* 2 hours; *Wrap Up:* 1 hour)

Setting:
Classroom

Skills:
Analyze, Calculate, Create, Demonstrate, Design, Develop, Discuss, Evaluate, Experiment, Identify, Inquire, Observe, Model, Present

Vocabulary:
berm, check-dam, cistern, drought-tolerant, elevation, erosion, gravity flow, gradient, ground water, impermeable, mulch, native species, percolation, permeable, plant guild, runoff, swale, waffle garden, water-efficient landscaping, water harvesting, Xeriscape™

Arizona Academic Standards:
Please see www.cals.arizona.edu/AZWATER/WET/standards/index.html for specific standards aligned with this activity.

Summary

Students explore the "watershed" of their school grounds to determine rainwater drainage patterns, calculate the amount of rainwater that can be collected from roofs of varying sizes, and then apply rainwater harvesting and smart landscaping techniques in the design of an attractive, water-efficient section of a school's grounds.

Objectives

Students will:

- analyze the "watershed" of their school grounds, identifying rainwater drainage patterns, permeable and impermeable surfaces, and places where water leaves the grounds;
- analyze the landscaping and turf areas of their school grounds and propose water-efficient alternatives where applicable;
- develop strategies for storing and using rainwater on the school grounds to water landscaping;
- develop strategies for natural cooling on school grounds;
- calculate the amount of rainwater that can be collected from roofs of varying sizes;
- identify native plants that are appropriate for desert landscaping in different areas of the state;
- explore techniques for rainwater harvesting and landscaping around a school yard;
- apply water-saving techniques to the design of landscaping that is water efficient;
- conduct a cost analysis to determine how much water and money are saved by choosing water-saving landscaping.

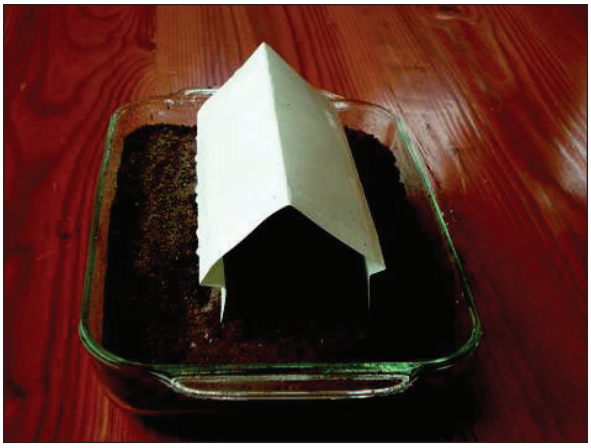
Materials

- *Spray bottle*
- *Large roasting pan full of fine-textured soil for*

soil pan demonstration
- *Cardboard or poster board* (1 sheet, 8 ½ by 11 inches)
- *Pencils*
- *Colored pencils* (1 set per student)
- *Rulers* (1 per student)
- *Garden and landscaping magazines* (optional)
- *Overhead transparency of* ***Landscapes Before and After*** *Student Copy Page* (optional)
- *Copies of* ***Average Monthly Rainfall Table*** (pages 306-307; 1 per student or an overhead transparency for the whole class to refer to)
- *Copies of the* ***Arizona Physiographic Provinces Map*** (page 42; 1 per student)
- *Copies of* ***Rainwater Harvesting Calculations*** *Student Copy Page* (1 per student)
- *Copies of* ***Steps for Designing Your Water-Efficient Landscape*** *Student Copy Pages* (1 per student)
- *Copies of* ***Sample Landscape Design: Step 1*** and ***Step 2*** *Student Copy Pages* (1 of each page per student)
- *Copies of* ***Design Your Water-Efficient Landscape (School #1, #2,*** and ***#3)*** *Student Copy Page* (1 of each per student)
- *Copies of* ***Save Water, Save Money*** *Student Copy Page* (1 per student)
- *Copies of* ***Native Plants for Water-Efficient Landscapes*** *Student Copy Pages* (1 set per student)
- *Calculators* (1 per student)

Preparation

1. **Assemble your soil pan for the rainwater harvesting demonstration.** Fill a large roasting pan with even-textured soil, about two inches deep. Make a roof by folding an 8 ½-by-11-inch piece of cardboard or poster board in half (to form peaked roof) with overhanging "eaves" and side walls, as shown in the photo.
2. **Make an overhead transparency of the *Landscapes Before and After Student Copy Page* (optional: you can also pass around your book to show these photos).**



Lissa Howe

A folded paper "house" in a tray of sand or soil provides a model for demonstrating rainwater harvesting concepts.

Background

In the hot and dry climates found in much of Arizona, outdoor water use for landscaping can consume tremendous amounts of water. Typically 60–90 percent of all water use by single-family residences is for landscape irrigation, and most of this is used to water turf grass. Choosing landscaping that requires less water can conserve significant amounts of water, as well as requiring less time to maintain. **Water-efficient landscapes** center around the efficient use of rainwater and the use of plants that are adapted for arid conditions. **Native species** that evolved in the local environment and are accustomed to its climate are ideal. Landscaping techniques that conserve water, control temperatures, and store available rainfall are now being applied in many areas of the state.

Native Plants

Using native plants not only conserves water, but also helps maintain healthy ecosystems by providing the food and shelter that other native species (insects, butterflies, birds, wildlife, etc.) require. Incorporating **plant guilds**— associations of plants that benefit each other and enrich the entire habitat—is important, as the various species

provide "services" to each other. For example, mesquite trees' roots harbor colonies of bacteria that fix nitrogen from the atmosphere (convert it into nitrate that is then available for plants' use). When the mesquite trees' nitrogen-rich leaves decompose in the soil, they release the nitrate, enriching the soil for other plants. The mesquite provide favorable habitat and carbon for the bacteria, and the bacteria provide surplus nitrate to the plants. Including legume plants (such as mesquite) that can enrich the nitrogen levels of the soil enhances the health of other plants and eliminates the need for chemical fertilizers.

Mulch

Mulch is material like pine needles, leaves, wood shavings, bark, gravel, or rock that helps hold moisture in the soil and controls erosion. Using mulch around plants conserves water by reducing evaporation, cools the soil surface, and makes the spaces between plants more attractive than bare soil.

Temperature Control

Controlling the temperature surrounding a building will reduce the amount of water needed for landscaping. Careful placement of shade trees and shade structures will provide cooling for plantings, for outdoor eating areas, and for the building itself. Keep in mind that the building itself will provide shade, but the shaded area will shift as the sun moves across the sky.

The angle and position of the sun in relationship to the building changes with the season as well as the time of day. The hottest part of a building is on the northwest side in the summer, during the afternoon. Heating in the winter begins in the morning on the southeast side of the building.

Rainwater Harvesting

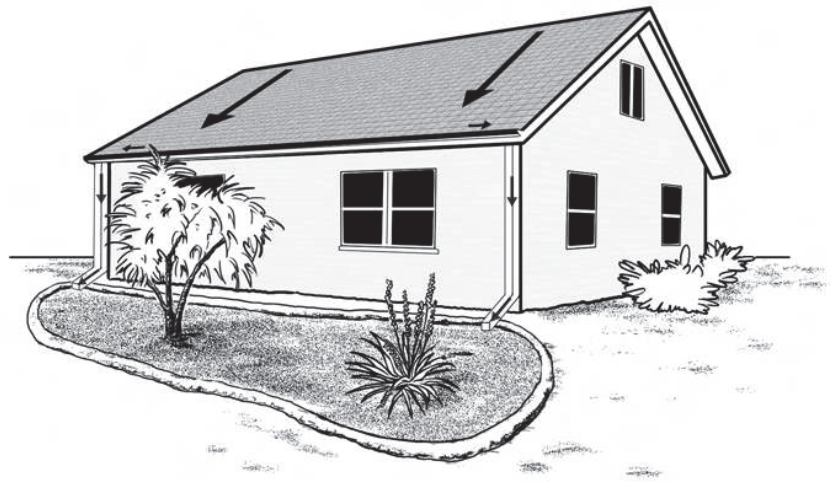
Another important aspect of water-efficient landscaping is the efficient use of rainwater. Arizona's native farming cultures have been masters at this for centuries. Since Arizona's rainfall is sporadic in its timing and amount, techniques for utilizing rainwater as efficiently as possible have been vital to human survival in the past, and remain valuable today.

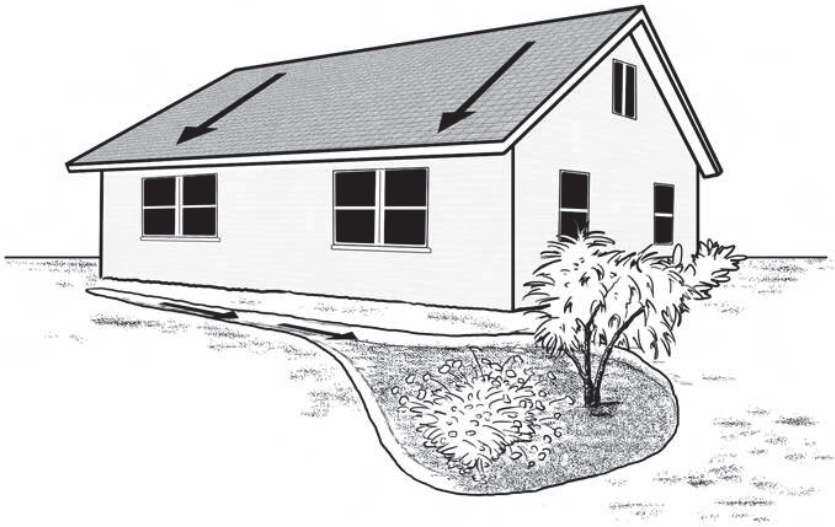
The main principle of efficient rainwater use is to prevent the water from running off the land surface before it has a chance to soak in and **percolate** deeply into the soil. This can be done in a number of ways: by building **check-dams** in small washes where water tends to flow rapidly, by building **swales** on gradual slopes to slow water flow, and by planting vegetation in low areas where water tends to pool. Arizona's monsoon thunderstorms are often characterized by very heavy, localized rainfall that lasts a short period of time. This type of rainfall can result in major **runoff** and **erosion**, especially in areas where the natural topography and vegetation have been altered.

Another key element to consider is the effect that **permeable** and **impermeable surfaces** have on rainwater runoff. Permeable surfaces, such as sand and soil, allow water to percolate through them, which slows the flow of runoff. Impermeable surfaces, such as roofs and streets, produce the maximum volume and rate of runoff. Capturing and storing the rainwater that runs off your roof can be an excellent way to conserve water.

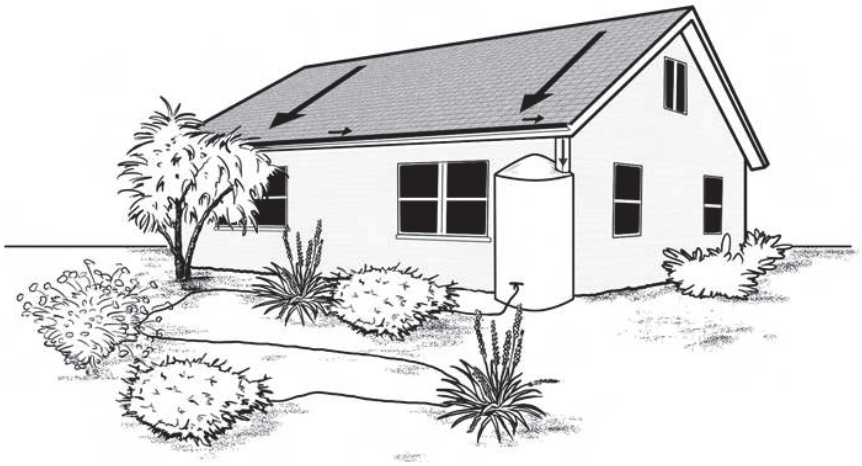
Rainwater harvesting systems can be as simple as having roof gutters that direct water into a **bermed** landscape holding area. In this model, rainwater is used immediately and is not stored in a holding tank.

In a more complex system, a **cistern** or rain barrel is used to store rainwater for future use. This is useful in Arizona because most of the precipitation falls during the winter wet season or summer monsoon season, and there are long periods of very little moisture in between. Having rainwater storage capacity can help provide a more predictable supply. Note: rainwater storage systems need to be covered to prevent mosquito larvae and should be labeled as non-potable water.





Two simple rainwater harvesting systems use bermed soil and drainage ditches to direct water from roof to planted areas.



This complex rainwater harvesting system uses gutters and downspouts to direct rainwater from the roof into a storage cistern. The storage cistern has a hose attached which leads to a drip irrigation system for watering plants.

Artist: Rachel Ivanyi, © Project WET

Rubric For Smart Landscape Design				
Criteria	**Effective means of storing and channeling water for beneficial use** (rain barrels, swales, etc).	**Effective means of temperature control** (shade trees, etc).	**Effective use of native, drought-tolerant plants** (nonnative plant use should be justified).	**Attractive and efficient landscape** (e.g., variety of plants of different sizes, colors).
Fully met.				
Partially met.				
Half met.				
Did not meet.				

Procedure

Warm Up

1. **Discuss what is meant by the terms *low-water use landscaping, Xeriscape*™** (prounced zeer-ih-scape)**, and *water-efficient landscaping.*** These terms are often used interchangeably to refer to landscapes that need little water to maintain them. Briefly discuss the rubric principles of "smart" landscaping (see **Background** section).
2. **Show students the "before and after" photographs on the *Landscapes Before and After Student Copy Page.*** When a homeowner, business owner, or institution is deciding what type of landscaping to maintain, the choices are endless. However, in the hot and dry climates found in much of Arizona, outdoor water use for landscaping can consume tremendous amounts of water. Choosing landscaping that requires less water can conserve significant amounts of water, as well as requiring less time to maintain. Water-efficient landscapes center around the use of plants that are adapted for arid conditions, often native species that evolved in the local environment.

The Activity

Part I

1. **Ask students, "What is a watershed?"** If this is a new concept for them, refer to the ***Warm Up*** section of "The San Pedro Connection," page 78). Follow the three steps described there to clarify the concept of a watershed.
2. **Ask students if they have ever tried to capture and store rainwater from their roof or water from a stream or arroyo.** Discuss some of the benefits of using rainwater: it is free; using it saves tap water; it doesn't contain salts so plants love it; if it is captured, it doesn't flood the streets. When a yard or grounds is designed to make maximum use of rainwater by having topography that slows its flow across the ground (berms, swales, etc.), more water can seep into the soil and help sustain soil moisture levels between rain events.
3. **Have students gather around the soil pan. Make sure you start with level, evenly deep soil.** Prop one end of the pan on a book with a one-inch spine.
   - Use the spray bottle to simulate rainfall on the "roof" of the house (see **Preparation**).
   - Observe the way the water runs off the roof, where it causes indentations to form in the soil, what runoff and erosion patterns result, etc.
   - Experiment with building small berms to slow the flow of runoff. Ask the students to brainstorm ways they could control the runoff and capture it to store it for future use.
   - Talk about using gutters to direct

rainwater, cisterns or rainbarrels to store it, and using the topography of the land to control where water runs.

- Ask them to think about how water flows off the flat roof of their school. Have they observed this happening? How is it directed to the ground and where does it flow after that?

4. **Take the class outside for a "watershed tour" of your school grounds.** Have each student bring a notebook to record their observations, and their ***Native Plants for Water-Efficient Landscapes*** *Student Copy Pages* (they will be looking at the photos of native plants later in the tour).
5. **Focus on the area around the building at first.**
   - Look for places where water drains off the roof, and follow the paths water would take, noticing where it leaves the school grounds. Where are high and low areas?
   - Does the rainwater get used to water landscaping, or does it get directed off the school grounds as quickly as possible?
   - Are there design features in the parking lots where water can flow into low, vegetated areas or is it curbed? Is most of the ground surface permeable or impermeable to water?
6. **After you have explored the rainwater drainage patterns of your school grounds and identified high and low areas, areas of high runoff, and areas where water can soak in, ask the students to brainstorm ways to keep the water on the grounds where it can be used to water landscaping and recharge the ground water.**
   - How could the rainwater be stored so that it can be used when needed?
   - Ask them to think about where they would place rainwater holding tanks, and how they would get the water from the tanks to the landscaping.
   - How big would the tanks need to be? Calculating the size of holding tanks will be practiced in ***Part II*** of this activity.
   - Can they think of ways to restore more natural topography to the school grounds to keep water from running off?
   - Are there places where concrete and asphalt could be replaced with more permeable surfaces such as sand or gravel to allow more water to soak into the ground?
7. **Now ask students to focus on the vegetation.**
   - How many different species of plants do they notice? Are there trees, shrubs, cacti, etc? How much of the grounds is covered with turf grass? Are the places that have grass used for play areas and eating areas or are they just to be looked at?
   - Have the students look at the photos of native plants in their packets. Do they see any of the native plants that are included in their packets growing on the school grounds?

RELATIVE PERMEABILITY OF SCHOOLYARD SURFACES

more permeable → **less permeable**

gravel | sand | pavers (sand between blocks) | concrete | asphalt

- Ask them to think about where they would incorporate native species in the landscaping and whether or not the turf grass (which uses high volumes of water) is necessary in all the places it is currently growing. Replacing turf grass with native vegetation (in decorative areas) or artificial turf (in playing areas) can conserve a lot of water.

Part II

1. **Tell students that they will be designing their own landscaping for a portion of a school's grounds, with systems for capturing and using their rainwater as well as native plants that are adapted for desert environments.** Refer to the activity on plant adaptations for arid environments, "Estivation, Ephemerals, and Xerophytes," (page 91) for information about why these species are able to survive with little water.
2. **Direct the class to work through the calculations on the *Rainwater Harvesting Student Copy Page.*** Provide the average annual rainfall tables for students to use as they calculate their roofs' water yields (see pages 306-309).
3. **Hand out the *Sample Landscape Design Student Copy Pages* (Step 1 and Step 2) and emphasize that this is only an example to help them visualize what their completed project may look like.** Share the rubric with them (see **Background**) and remind them to focus on efficient use of rainwater (keeping rainwater on the grounds), temperature control, and use of native plants.
4. **Hand out the *Steps for Designing Your Water-Efficient Landscape Student Copy Pages* and review the steps as a class.** Encourage students to think about the shade the building provides and which plants like full sun and which like partial sun when they are deciding where to place them. Ask them to think about ways to naturally cool the school building as they design their landscapes.
5. **Hand out the *Design Your Water-Efficient Landscape Student Copy Pages* (Schools #1, #2, and #3) and the *Save Water, Save Money Student Copy Page*.**
   - Students may use their notes from their watershed tour of the school grounds (***Part I*** of the activity) to shape their landscape design, or they may create a hypothetical school yard.
   - Allow students to work individually as they design their landscapes and complete the calculations.
   - Remind them to refer to the ***Native Plants*** pages you handed out to them earlier in the activity. (You may want to develop an additional, more detailed assessment rubric for the project that specifies, for example, the number of plants required, a gutter, cistern, etc.)

Rainwater Harvesting Calculations
Answer Key

Roof Square Footage:
SCHOOL #1 = 36,800 square feet
SCHOOL #2 = 154,400 square feet
SCHOOL #3 = 85,950 square feet

Wrap Up

1. **After all of the students have finished their landscape designs, discuss the answers to the calculations on the *Rainwater Harvesting* and *Save Water, Save Money* worksheets.**
2. **Have students share their landscape designs with the class as a whole, focusing on items in the rubric.**
3. **Discuss the activity.** What were the challenges presented by the different school layouts? Are

there concepts that they learned through doing the activity that they could apply at home?

Assessment

Have students:

- identify features that make up the "watershed" of their school grounds, including rainwater drainage patterns, permeable and impermeable surfaces, and places where water leaves the grounds (***Part I***, Steps 4–7);
- identify components of landscaping and turf areas on their school grounds and propose water-efficient alternatives where applicable (***Part I***, Step 7);
- explain strategies for storing and using rainwater on their school grounds to water landscaping (***Part I***, Step 6);
- calculate the amount of rainwater than can be collected from roofs of varying sizes (***Part II***, Step 2);
- identify native plants that are appropriate for desert landscaping (***Part II***, Steps 3–5);
- demonstrate techniques for rainwater harvesting and landscaping around a school grounds (***Warm Up***, Steps 1–3; ***Part II***, Steps 1–4);
- demonstrate strategies for natural cooling on a school grounds (***Part II***, Step 4);
- demonstrate water-saving techniques in the design of landscaping that is water efficient (***Part II***, Step 5);
- conduct a cost analysis to determine how much water and money are saved by choosing water-saving landscaping (***Part II***, Step 5);
- present their water-efficient landscape designs (***Wrap Up***, Step 2)

Extensions

Take a field trip to a desert demonstration garden, or have a landscaper or horticulturalist visit your classroom as a guest speaker.

Plant a tree (or combination of low-water plants) with your students in a place where it can receive rainwater runoff and use a mulch pit to hold water in the soil around the tree.

Have students design a demonstration garden for their school that is educational and aesthetically pleasing.

Have the class design a rainwater harvesting system for your school. Have them measure the roof area and calculate the amount of rainwater that could be harvested from it, then estimate the volume of containers that would be needed to hold this amount of water.

If your school has an air conditioning system, have students investigate the condensate produced—measuring the amount, identifying where it goes, etc.—and research systems that reuse condensate. Have them propose a system for reusing the school's air conditioner condensate for outdoor watering.

Case Studies

Tucson: Living as a Desert Community **(page 302)**
The Heart of Rim Country **(page 286)**
City of Seven Wonders **(page 275)**

Recommended Reading		
Grades K–5	**Grades 6–8**	**Grades 9–12**
Arid Lands, Sacred Waters: Student Activity Packet (Marne Potter and Caitlyn Howell)	*Water Conservation: Student and Teacher Editions* (E2: Environment and Education)	*Handbook of Water Use and Conservation: Homes, Landscapes, Businesses, Industries, Farms* (Amy Vickers)
A Walk in the Desert (Rebecca Johnson)	*Rocky Mountain Tree Finder: A Pocket Manual for Identifying Rocky Mountain Trees* (Tom Watts)	*Desert Waters: From Ancient Aquifers to Modern Demands* (Arizona-Sonora Desert Museum)
	Canyon Country Wildflowers (Damian Fagan)	*Shrubs and Trees of the Southwest Deserts* (Janice E. Bowers)

K–6 Options

The soil pan demonstration (Step 1) works well with K–6 level students and can be extended by providing small groups with their own soil pans, spray bottles, and "roofs" to experiment with.

Illustrate the concept of runoff vs. water retention by using a muffin tin or Styrofoam egg carton and a spray bottle. Turn the tin or carton upside down, spray the water, and observe how it rapidly runs off the high points and then off the tin entirely. Now turn it over, spray again, and observe the water pooling in the depressions. Repeat the experiment on a crumpled sheet of paper and watch the water run off and pool. The paper will absorb some water, so it won't run off as rapidly as it will off the metal or plastic containers. Discuss the concepts of permeability and impermeability, then take a walk outside to the playground to compare ground surfaces. Bring a jug of water to test students' hypotheses about which surfaces will be most permeable (e.g., grass vs. concrete vs. sand vs. asphalt).

Resources

Arizona Municipal Water Users Association. 2004. *Landscape Plants for the Arizona Desert*.

Ellefson, Connie Lockhart, and David Winger. 2004. *Xeriscape Colorado: The Complete Guide*. Engelwood, CO: Westcliffe Publishers, Inc.

Mollison, Bill. 1988. *Permaculture: A Designers' Manual*. Tasmania, Australia: Tagari Publications.

Phillips, Steven J., and Patricia Wentworth Comus, eds. 2000. *A Natural History of the Sonoran Desert*. Tucson: Arizona-Sonora Desert Museum Press.

Sovocol, Kent A., et al. February 2006. "An in-depth investigation of Xeriscape as a water conservation measure." *Journal AWWA* (American Water Works Association): 98:2.

Waterfall, Patricia H. 2004. *Harvesting Rainwater for Landscape Use*. Tucson: University of Arizona Cooperative Extension and Arizona Department of Water Resources.

Water Resources Research Center. 2005. *Desert Landscaping: Plants for a Water-Scarce Environment.* Multimedia CD-Rom. Tucson: University of Arizona Water Resources Research Center.

e-Links

Arizona Municipal Water Users Association
Information and links about water conservation in the Phoenix metro area.
www.amwua.org/conservation_main.htm

City of Glendale Garden pages
Information and resources about water-efficient landscaping.
www.glendaleaz.com/news/090106_GardenVariety.cfm

City of Tucson Water Harvesting Guidance Manual
Downloadable PDF version.
http://dot.ci.tucson.az.us/stormwater/education/waterharvest.cfm

Desert Botanical Garden, Desert House Project
Links and information for household water conservation and landscaping tips.
www.dbg.org/center_dl/desert_house_toc.html

Native Seeds/SEARCH
Source for native seeds and information about Arizona native crops.
www.nativeseeds.org/

The Arboretum at Flagstaff
Information about landscaping with native plants in the Flagstaff area.
www.thearb.org

Landscapes Before and After

Kerry Schwartz

The front yard of a home before water-efficient landscaping was installed.

Kerry Schwartz

The front yard of the same home, after water-efficient landscaping was installed. Desert-adapted plants and permeable ground surfaces (gravel, paving stones) are used in order to use rainwater efficiently and minimize the need for watering plants.

Rainwater Harvesting Calculations

Directions:

1. Choose a school aerial view from the three shown on pages 136, 137, and 138. Trace the outline you've chosen onto two additional sheets of white paper so you have three views to draw on.

2. Use the measurements for length and width to calculate the amount of square footage for the roof (LENGTH x WIDTH of a rectangle = square feet).

3. Use the chart below to calculate how much water can be harvested from the roof. You will need to refer to the table for average monthly rainfall for your community (provided by your teacher) to fill in column A. If your community is not included in the table, use the numbers for the city in the table that is nearest to you.

How Much Water Can Be Harvested From Your School's Roof?						
	A	**B**	**C**	**D**	**E**	**F**
For each month of the year, follow the instructions to fill in its row.	Enter the amount of rainfall for each month for your city.	Multiply the number in column A by .623 to convert inches to gallons per square foot.	Enter the square feet for the roof you chose.	Multiply column B by column C. This is the maximum gallons of rainfall per month.	Multiply column D by the given "runoff coefficient." This represents how much of the rain that falls on the roof will run off (95%). Enter your answer in column F.	This is the total gallons of water that can be harvested each month (the remainder may be lost to evaporation).
January					.95	
February					.95	
March					.95	
April					.95	
May					.95	
June					.95	
July					.95	
August					.95	
September					.95	
October					.95	
November					.95	
December					.95	
TOTALS					.95	

Steps for Designing Your Water-Efficient Landscape

I. Your Rainwater Harvesting System

Envision an area of land on one side of your school building. Where are the high points and where are the low points? What areas are level? Follow the directions on this page to design your rainwater harvesting system for the school of your choice (make all drawings on pages 136, 137, or 138).

1. Keep all drawing within the box that represents the edge of the school grounds.
2. Indicate high points with a plus sign. Use a red pencil.
3. Indicate low points with a minus sign. Use a blue pencil.
4. Indicate level areas by lightly shading them. Use a yellow pencil.
5. Draw the street that the school is located on, sidewalks and walkways, and other non-vegetated areas (playing courts, sand or gravel areas, etc.). Draw rocks and boulders in landscaped areas. Use a black pen.
6. Design your rainwater capturing system. Think about:
   - Where does the water drain off the roof?
   - Do you want to direct the water into holding tanks or into natural holding areas?
   - If the water runs directly off of the roof, how will you capture it and direct it onto plants?
   - Are there places where you want to construct berms to slow the flow of runoff?
   - If you are using a holding tank with a hose attached, how will you design your watering system to get water to plants?
7. Draw roof drains, rainwater holding tanks, watering systems, berms, and other features of your rainwater system (using symbols and a key to them) onto the layout of your choice. Use a black pen.

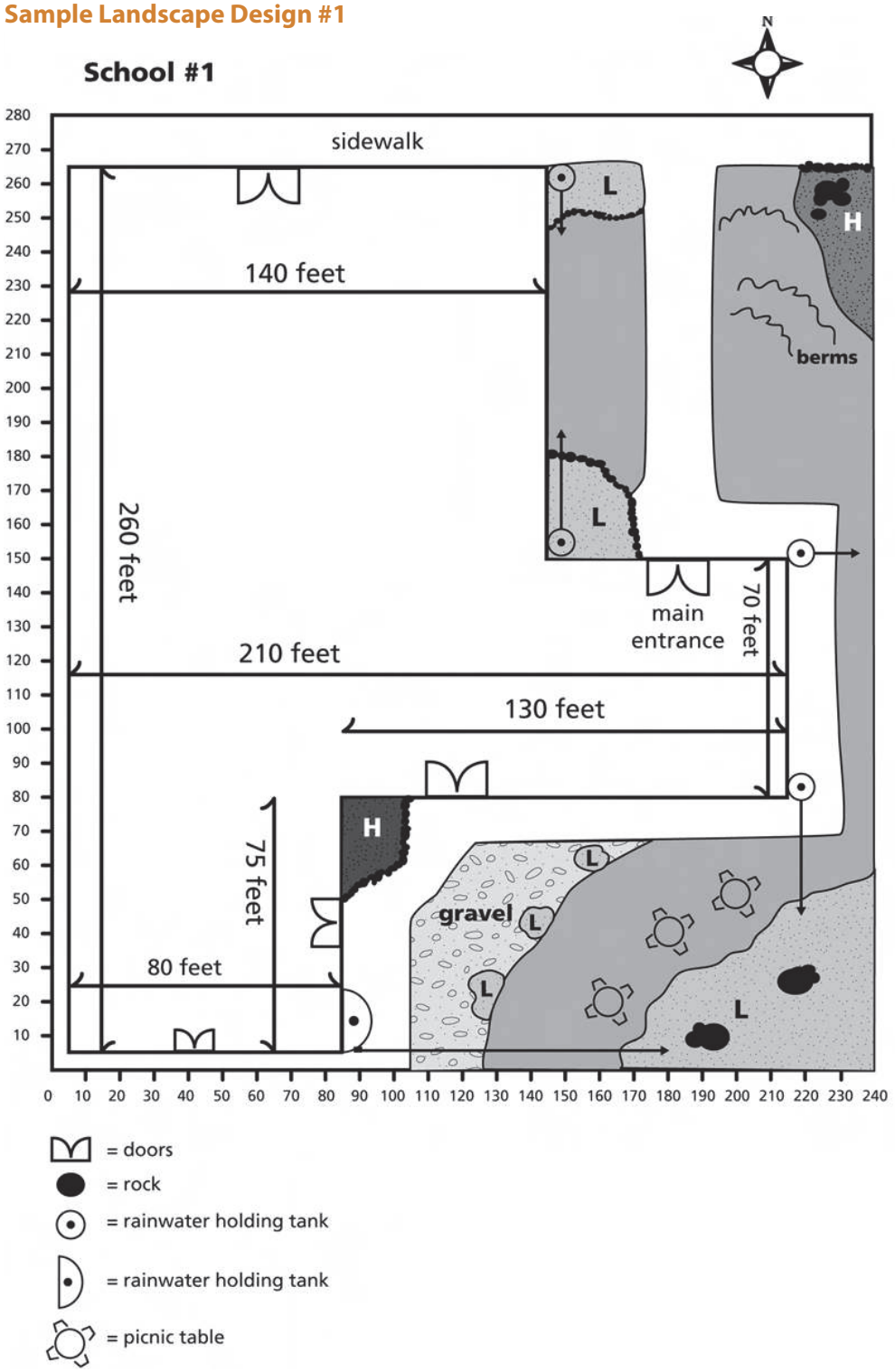
Steps for Designing Your Water-Efficient Landscape, continued

II. Choosing Native Plants for Your Landscaping

1. Start with a new copy of the school outline. This time you will design your landscaped areas and add plants to make the grounds attractive and shaded.
2. Choose from the list of native plants on pages 141–143. These plants have evolved in the arid Southwest and are good choices for landscaping that uses minimal water. *The only plant on the list that is not native is Bermuda grass, which is a turf grass.* Think carefully about how much turf you need since it uses the most water (73 gal. per square foot on average, compared with 17 gal. per square foot on average for native desert landscaping).
3. Color-code each type of plant from the chart (for example, use green for all trees, purple for shrubs, brown for cacti, and so on).
4. Use the icons shown beside the plants' names to represent them on your design layout.
5. Think about the low and high areas. Locate plants that need water regularly in low areas.
6. As you design your landscaping, plan for natural cooling of the building.
7. You can use the same plant species more than once in your design. Think about what will look beautiful, considering the colors the flowers will be when blooming, what heights the plants will be, what places in your school yard have the most shade and sun, etc.

III. Make a key for your landscaping design to tell which colors and symbols are used for which types of plants, etc. Write a paragraph or more describing your landscape design.

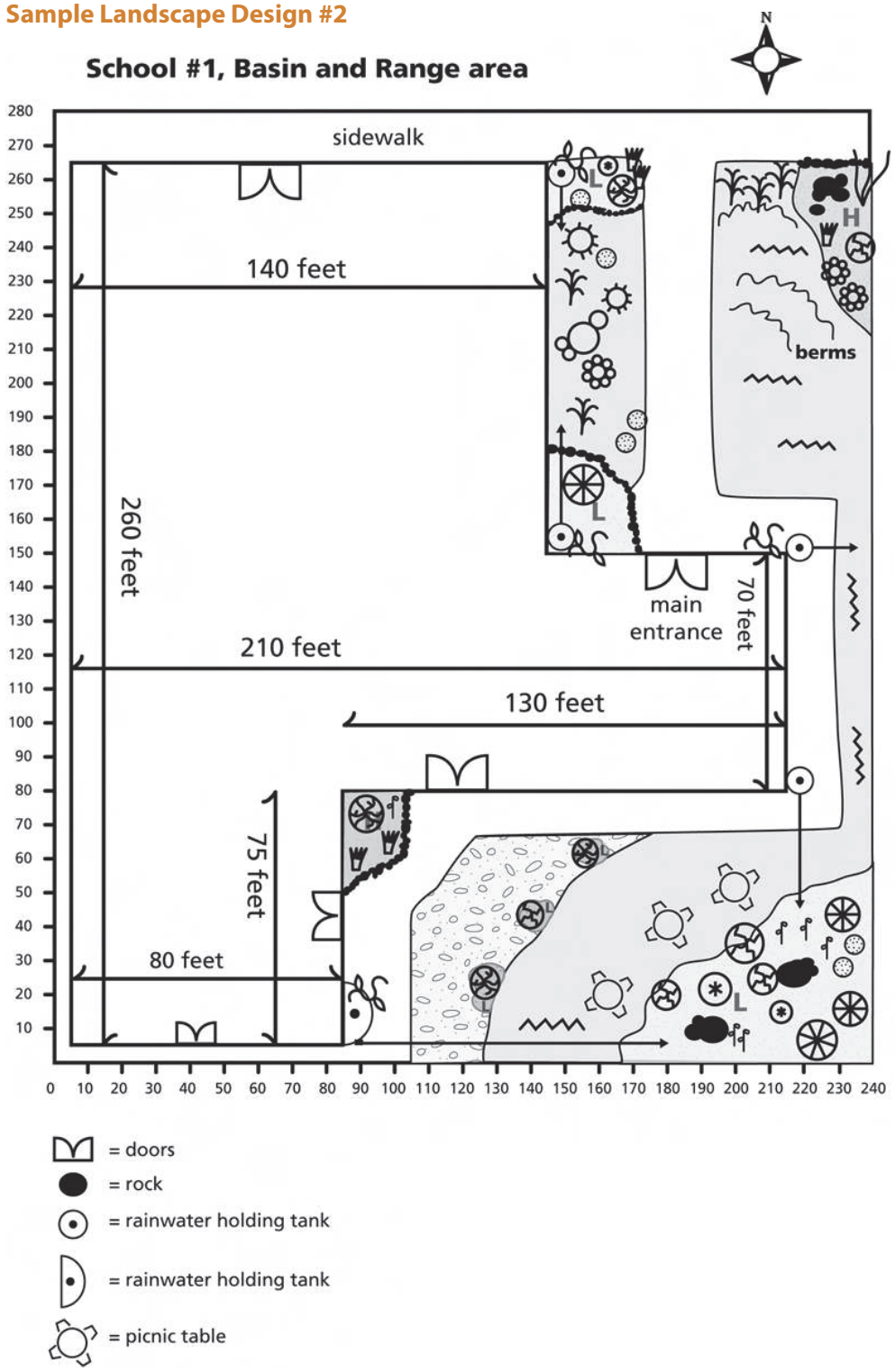
Sample Landscape Design #1



This sketch includes the sidewalks, gravel areas, rainwater harvesting system, high and low areas, berms, picnic tables, rocks, and everything else in the landscape besides plants (see Sample #2 for plants).

Artist: Rachel Ivanyi, © Project WET

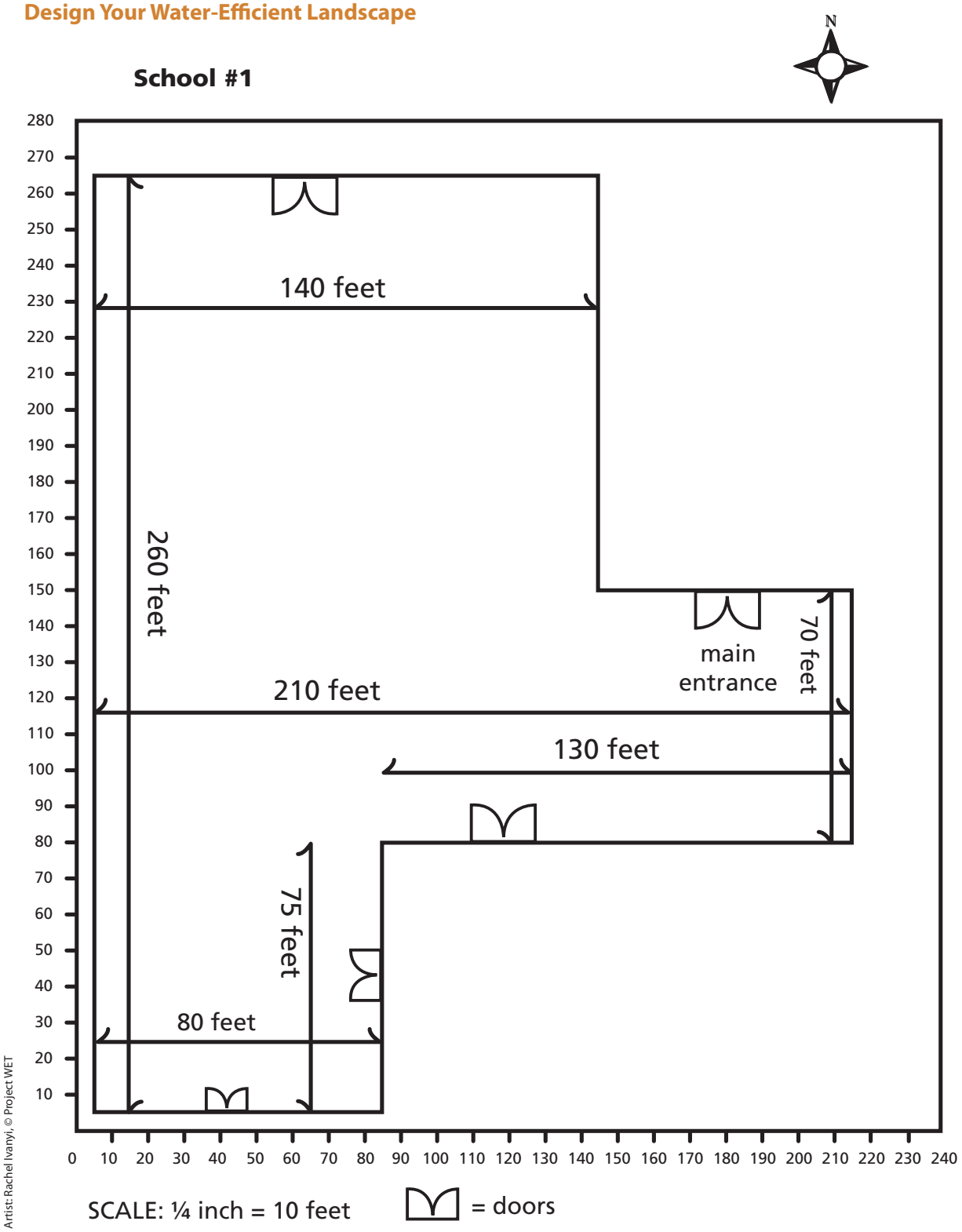
Sample Landscape Design #2



This sketch includes the sidewalks, gravel areas, rainwater harvesting system, high and low areas, berms, picnic tables, rocks, and **plants**.

Artist: Rachel Ivanyi, © Project WET

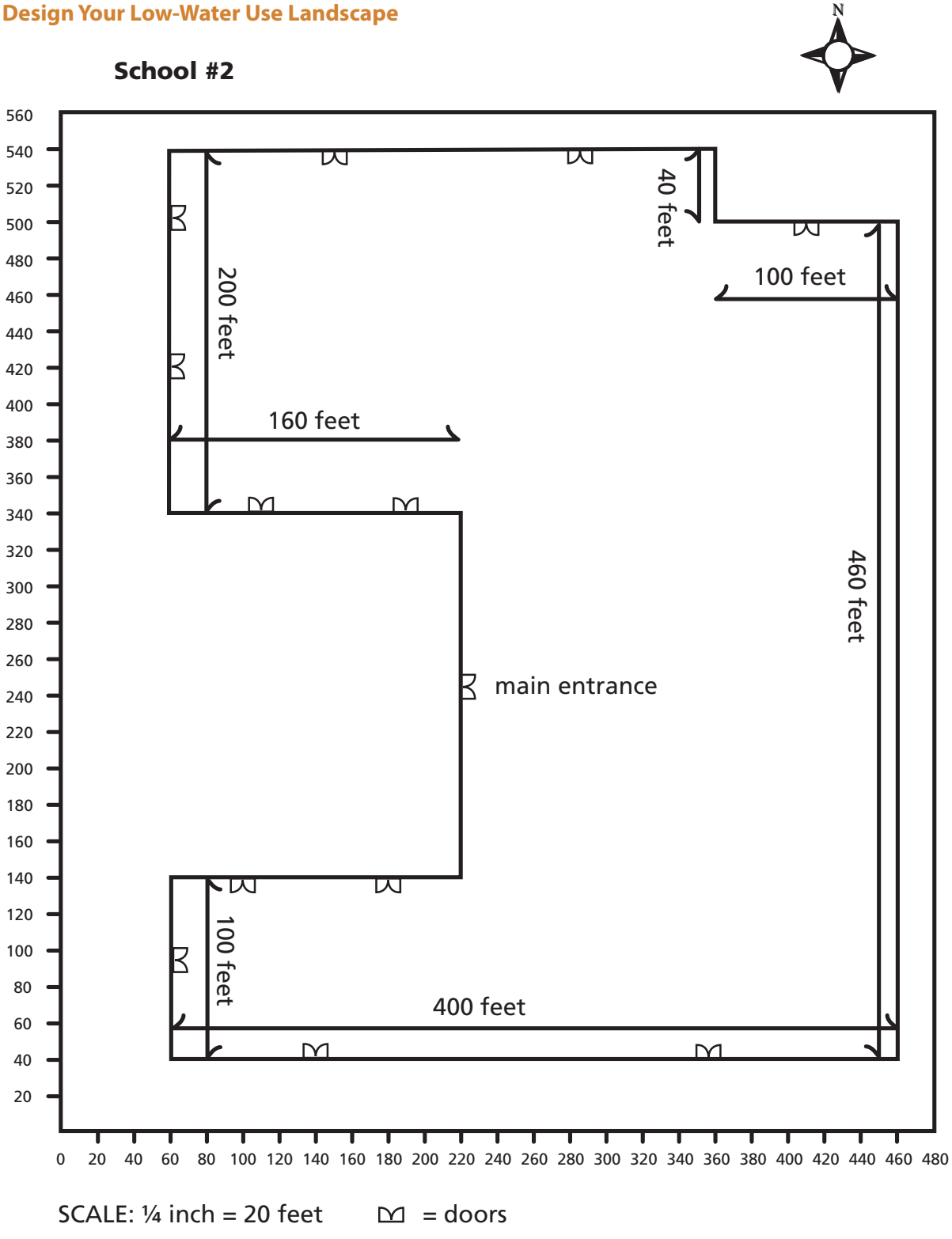
Design Your Water-Efficient Landscape



Artist: Rachel Ivanyi, © Project WET

Design Your Low-Water Use Landscape

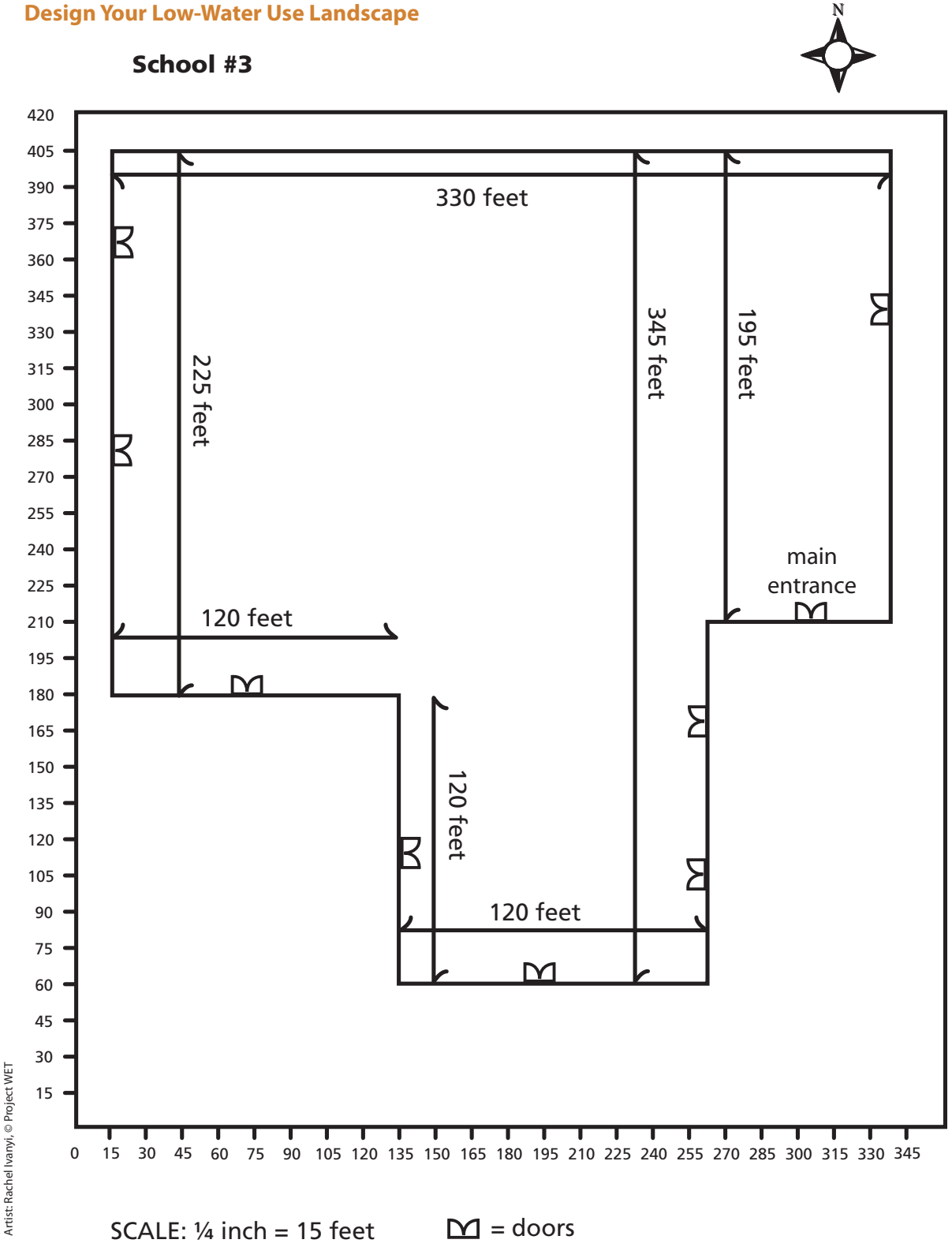
School #2



Artist: Rachel Ivanyi, © Project WET

Design Your Low-Water Use Landscape

School #3



SCALE: ¼ inch = 15 feet = doors

Artist: Rachel Ivanyi, © Project WET

Save Water, Save Money!

In southern Nevada, which has a similar climate to central and southern Arizona, a study was conducted to find out how much water is saved when families replace their turf grass lawns with water-efficient, desert landscaping.[13] Here are the results:

Replacing Turf Grass With Water-efficient Landscaping:

- SAVES 56 gallons of water per square foot (turf uses 73 gal. versus 17 gal. for desert landscaping).
- REDUCES total household water use by 30 percent each year.
- SAVES an average of 96,000 gallons of water per year per family.
- SAVES an average of $0.15 per square foot in water costs.

1. **For your low-water-use landscape, estimate the amount of water needed per year.** (Tip: Estimate the area [square feet] of your landscape that is turf and multiply this number by 73 gal. Then estimate the area of landscape that is desert landscape and multiply this number by 17 gal. Add the numbers together for your total water use per year.)
2. **Based on the amount you calculated above, how much water do you need *in addition to* the rainwater you harvest from the roof in an average year?**
3. **How much money could your school save in a year with your water-efficient landscape, compared to the same landscape using all turf in place of desert landscaping and without capturing and using rainwater efficiently?**
4. **If your school could use the money saved on water bills to do anything it wanted, how would you suggest that the money be spent?**

Paul Charman

Water-efficient landscaping beautifies the entrance to Sequoya Elementary School in Scottsdale.

13. *Sovocol, Kent A., et al. February 2006. "An in-depth investigation of Xeriscape as a water conservation measure." Journal AWWA (American Water Works Association): 98:2.*

Native Plants for Water-Efficient Landscapes

Choose from the following list of native plants as you design your school's landscaping. Use the icons shown beside the plants' names to represent them on your design layout in the suggested color. ***Note:*** perennial plants are those that continue to grow year after year, while annual plants die every year and sprout again from seeds.

Look at the **Physiographic Provinces Map** to find your location and choose plants from the list below that are found in your area (see column 2).

Artist: Rachel Ivanyi, © Project WET

TREES—dark green						
Photograph[14]	**Name**	**Area of Arizona**	**Cold Tolerance**	**Sun Preference**	**Water Requirements**	**Special Features**
	white thorn acacia	Basin and Range	to 5˚	full sun	very low	Yellow puffball flowers. Attracts birds.
	desert willow	all areas	to 0˚	full sun	low	White, pink, purple flowers attract hummingbirds.
	velvet mesquite	Basin and Range	to 0˚	full sun	very low	Pale yellow flowers. Excellent for wildlife.
	ponderosa pine	Colorado Plateau Mogollon Rim	below 0˚	full or partial sun	moderate	Excellent for squirrels and birds.
	Rocky Mountain juniper	Colorado Plateau Mogollon Rim	below 0˚	full or partial sun	low	Seeds attract birds.
SHRUBS—purple						
	four-wing saltbush	all areas	to 0˚	full sun	very low	Excellent for wildlife.
	pink fairy duster	Basin and Range	to 5˚	full sun	very low	Pink powder-puff flowers attract hummingbirds.
	turpentine bush	Mogollon Rim Basin and Range	to 5˚	full sun	very low	Yellow flowers. Seeds attract birds.
	Apache plume	all areas	below 0˚	full or partial sun	very low	White flowers. Attracts wildlife.

GROUNDCOVERS AND VINES—blue						
Photograph[14]	**Name**	**Area of Arizona**	**Cold Tolerance**	**Sun Preference**	**Water Requirements**	**Special Features**
	white evening primrose	Mogollon Rim Basin and Range	to 10˚	full or partial sun	low to moderate	Low groundcover with large white to pink flowers.
	grape ivy	Basin and Range	to 20˚	full sun or shade	low	Vine.
	Oregon grape	Colorado Plateau Mogollon Rim	below 0˚	partial sun or shade	low to moderate	Yellow flowers, blue/purple berries.
Cacti—brown						
	saguaro	Basin and Range	to 18˚	full sun	very low	Red fruits attract birds.
	Engelmann's hedgehog	all areas	to 10˚	full sun	very low	Vivid pink flowers.
	common prickly pear	all areas	to 0˚	full to partial sun	very low	Yellow flowers.
SUCCULENTS—orange						
	ocotillo	Basin and Range	to 10˚	full sun	very low	Red flowers attract hummingbirds
	beargrass	all areas	to 0˚	full to partial sun	very low	Evergreen.
	banana yucca	all areas	to 0˚	full sun	very low	Showy flower stalk.

GRASSES—light green						
Photograph[14]	**Name**	**Area of Arizona**	**Cold Tolerance**	**Sun Preference**	**Water Requirements**	**Special Features**
	blue grama	all areas	to 0˚	full to partial sun	moderate	Good for-natural-looking meadows.
	deer grass	all areas	to 0˚	full or partial sun	low	Grows in bunches. Decorative.
	Bermuda grass (NOT native to the Southwest US.)	all areas	to 0˚	full sun	Low in winter, high in summer.	Turf grass; use for lawns or play areas.
PERENNIAL WILDFLOWERS—red						
	desert marigold	all areas	to 10˚	full sun	low	Yellow flowers, blooms for a long time.
	blackfoot daisy	all areas	to 0˚	full to partial sun	low	White and yellow flowers, spreads.
	canyon penstemon	all areas	to 0˚	full to partial sun	low	Rose-colored flowers attract hummingbirds.
ANNUAL WILDFLOWERS—yellow						
	blanket flower	all areas	dies in winter	full sun	low	Red and yellow flowers.
	blue flax	all areas	dies in winter	partial sun	low	Blue flowers. Reseeds itself easily.
	owl's clover	Basin and Range	dies in winter	full to partial sun	low	Rose-pink flower spikes.

14. Credits for the photographs in this table are as follows: All photos courtesy of the University of Arizona Water Resources Research Center (Desert Landscaping CD) except: pink fairy duster (Ursula Schuch, University of Arizona Plant Sciences Dept.); beargrass (Toni Moore, Master Gardener, Pima County); banana yucca, creosote bush, Engelmann's hedgehog (Kerry Schwartz); grape ivy (Sandra Rode); and four-wing saltbush, Oregon grape, Bermuda grass, prickly pear, blue grama, ponderosa, juniper (Lissa Howe).