Chapter Contents

Xeriscape Principle

A well-planned and well-maintained irrigation system can significantly reduce landscape water use. High-water-use and low-water-use plants should be in different irrigation "zones."

Key Concepts

Types of irrigation systems and devices (e.g., sprinklers, drip emitters), plant irrigation zones, rainwater harvesting.

Teacher's Notes

Designing irrigation zones and choosing proper irrigation equipment are two of the most important decisions to make when maximizing landscape water efficiency. For the most efficient use of water, turf areas (lawns) should be irrigated with sprinklers. Trees, shrubs, flowers, and groundcovers can be watered efficiently with low-volume drip emitters, sprayers, and bubblers. Irrigation zones should be designed so different types of plants receive the amounts of water they need with a minimum of water waste. For example, lawn areas and low-water-use (xeric) plants should be in different irrigation zones so that they can be watered independently of each other.

In **Problem to Solve: Harrison and Siebert Irrigation Project,** students are asked to recommend an irrigation system for one of the suburban landscapes presented. The Harrisons are an older couple who travel out of town for extended periods of time. They like their suburban Kentucky bluegrass lawn to be green at all times—even when they aren't home to water or enjoy it. The Sieberts have a xeriscaped front yard and a buffalograss lawn with a rose garden in the back yard. The landscaping choices they have made reflect the family's interest in using land-

Teacher's Notes, continued

scape water wisely. All students will communicate with the selected homeowners in the medium of their chosing (letter, drawings or schematics, etc.) to recommend the type of irrigation that would be most appropriate for their property. **The Problem to Solve** introduced in this section will be expanded upon in **Chapter Seven: Maintenance,** so keep the students' work for future reference.

The **Project Cover Sheet** outlines the tasks that the students will complete for this chapter. Level 1 students will complete the activities and communicate with the selected homeowners. Prior to communicating with the homeowners, Level 2 students will draw a landscape irrigation plan for the selected property and prepare a cost analysis of the proposed irrigation system.

The **Student Handout** provides background information designed to give the students a brief overview of irrigation systems and practices. The **Charts and Graphs** handout lists the selection, number, and spacing of drip emitters for different types and sizes of plants. This student information can be supplemented with irrigation system pamphlets that are usually available in hardware or landscape stores. (Among the many websites that include online catalogues and brochures are www.dripworksusa.com, www.homecenter.com/dept/irrigation/, and www.submatic.com.)

Assessment of Problem to Solve

In **Problem to Solve: Harrison and Siebert Irrigation Project,** students are asked to recommend an irrigation system for one of the landscapes presented. Each of the landscapes presents its own challenges, and both have a variety of possible solutions. The first step is for each student to draw a simple schematic diagram of the landscape. There is no one correct schematic, so you will see a variety of drawings. Next, students should divide the landscape into two or more irrigation areas or "zones." (**NOTE:** To simplify this activity for students, design the schematic or line drawing of both landscapes ahead of time and provide copies for the students. Doing so will force all students to work with the same landscape parameters.)

The **Problem to Solve** should be evaluated to determine whether the recommendations are correct, presented in sufficient detail, and successfully communicated to the homeowner.

Here are some of the specific characteristics for each landscape:

<u>Harrison:</u> The Harrison landscape has two to four irrigation zones. The front yard can either be one zone that includes the grass lawn and the flowerbeds, or it can be separated into two zones. The best option for irrigating the front lawn is a sprinkler system, either manually controlled or on an automated timer. Likewise, the back yard can be irrigated using either one or two zones. The trees and groundcover can be a separate zone, or this area can be part of the lawn zone. If the fruit trees are grouped together, they could easily be put on a drip irrigation system. However, if the trees are spread throughout the yard, students might choose to leave them on the same irrigation zone as the lawn.

In choosing any system for this household, the students should consider that the Harrisons travel for extended periods. Therefore, an automated system would work best. (Make sure that each student gives a good explanation of the system he or she chooses.)

<u>Seibert:</u> The Seibert landscape has two to five irrigation zones. The front yard can be considered one zone of all native plants, or a second zone could be created to water just the desert willow trees. Drip irrigation or hand-held watering would be best for this landscape. A sprinkler system would be inappropriate.

The Seibert's back yard has a rose garden, buffalograss, and established trees. It should be separated into at least two zones—one for the rose garden and one for the rest of the yard. A third zone could be created for the established trees, again depending on whether the student spread them out over the yard or grouped them together. A drip system would probably work best for the rose garden; a sprinkler system, either manually operated or automated, would work well for the grass. If the trees comprise a separate zone, either a drip system or hand watering would be appropriate.

Notes on the Activities

Moving Water Around – This activity is a simulation of the three main types of irrigation that are used in New Mexico - flood, drip, and sprinkler, along with the optional introduction of a relatively new technology, subsurface drip irrigation. The activity is designed as a demonstration for the class, but it can also be done in small groups if the materials are available. Students should observe the following:

- With **flood irrigation**, water flows over the surface of the soil. Some of the water will run off if the area is not surrounded by berms,[1] and there may be some soil erosion. Because the entire area must be wetted and there may be runoff, flood irrigation requires more water than drip irrigation and is therefore not as efficient.
- With **sprinkler irrigation**, the entire area is wetted. However, because water is applied more evenly and more slowly than with flood, there is little or no runoff and less water is required. While sprinkler irrigation is more efficient than flood, water lost to evaporation and wind-drift can be very high. For areas planted in grass, sprinklers are generally the best choice for efficient irrigation.
- **With drip irrigation**, only a small area around the plant is wetted to saturate the root zone and there is little or no runoff from the soil surface. For individual plants, drip irrigation is usually the best choice.
- With **subsurface drip irrigation**, a small area around the plant's roots is wetted and may not be visible from the surface. There is little or no runoff from the soil. This option works well for individual plants but is also proving itself to be an option for large areas of turf.

Water Around My School – Students draw a site plan of their school's property that includes irrigated areas and the types of irrigation used in the various areas. Students will also test sprinkler irrigation systems to determine water usage. The plans drawn up

Irrigation Systems Compared

Irrigation System	Advantages	Disadvantages
Flood	3 Easy to use 3 Inexpensive	3 Erosive tendencies 3 Tendency to run off instead of infiltrate 3 Ditches need to be maintained
Sprinkler	3 Moderately easy to use 3 Most effective for turf areas	3 Expensive to install and operate 3 Water lost to evaporation and wind 3 Must be maintained
Drip	3 Easy to use, once installed 3 Gets water directly to plants' roots 3 No erosion or waste of water	3 Must be maintained 3 Clogs fairly easily
Subsurface Drip	3 Easy to use, once installed 3 Gets water directly to plants' roots 3 No erosion or waste of water	3 Not easy to maintain or fix

in this activity could be used for many xeriscape-related activities. Students can be evaluated on the accuracy of their measurements and area calculations and on the quality of their drawings.

Too High, Too Low, Just Right – Using the landscape plans provided, students determine the amount of water used for irrigation. Answers will vary depending upon how students allocate water use. Students are asked to assign each area in a landscape a high-, medium-, or low-water-use designation according to the plant type. For this exercise, grass is high-water-use, flowers and trees are medium-water-use and shrubs are low-water-use. A chart has been provided to designate how much water each of these zones will use throughout the year. (NOTE: The gallons-per-week numbers were chosen to illustrate the differences in water-use zones and are not necessarily accurate.)

Design-a-Drip – Students will design a drip irrigation system on the landscape plan provided. The student plans can be evaluated based upon the thoroughness and the quality of the plan. The irrigation systems used should be compatible with the types of plants shown in the plan and should reflect an understanding of the information learned from previous activities in this unit. Installation and operating costs should accurately reflect the materials called for in the irrigation plan designed by the student.

Rainwater Harvesting – As an introduction to the concept of rainwater harvesting, this activity asks students to calculate the amount of water that can be captured from a roof, design berms to see how water can be directed, and create a plan for a rainwater harvesting system. There are two levels of student worksheets for this activity, both of which ask students to calculate the gallons of water harvested. The gallons harvested will vary depending upon which town in New Mexico the student uses for annual rainfall figures. However, the variables and the calculation should be as follows:

- Record the annual rainfall of the town chosen from rainfall chart in Appendix C
- Multiply that figure by 0.623 to convert the annual rainfall from inches to gallons per square foot
- Multiply by 1,625 square feet (the calculated area of the roof)
- Then multiply by a typical runoff coefficient, 0.90

Annual rainfall x .623 gallons per ft^2 x 1,625 ft^2 x .90 = supply in gallons

If the largest portion of the roof was increased to 65 feet by 25 feet, the total area of the roof would be 2,125 square feet.

The runoff coefficient represents the amount of water that actually runs off the roof or other surface. The runoff coefficient for this equation is 90 percent or .90, but in Level 2, 95 percent is also acceptable. The remaining 5 to 10 percent is lost to evaporation. Use the low coefficient (90 percent) for a metal roof in the middle of summer, as this would cause a higher evaporative loss of approximately 10 percent.

Another surface from which rainwater can be harvested is concrete or asphalt paving. A good way to water plants adjacent to a driveway or parking lot is to use land contouring —such as depressions and berms— to catch the water and direct it to the desired landscape area.

Teacher Tip:
Use the questions imbedded in the student reading pages to lead a class discussion.

Complementary Activities

The following activities complement the **Problem to Solve** for this chapter:

✓ **2-2: Holes in the Soil**
✓ **4-3: A World of Mulches**
✓ **5-3: Deep, Deeper, Deepest**
✓ **6-7: A Desert Blooms in My Garden**

Background Information: Irrigation Practices

In arid areas such as New Mexico, most landscapes need supplemental irrigation (extra water above and beyond naturally falling precipitation) to thrive. During the hot summer months, landscape watering can comprise 50 to 70 percent of a suburban family's total water use. Fortunately, a well-planned and well-maintained irrigation system can significantly reduce the amount of water needed to keep a landscape healthy.

For the most efficient use of water, assess the site to determine the optimum water-delivery system (or systems) for the various plants. There are several methods that can be used to add supplemental water, including flood irrigation, hand watering, automated sprinklers, drip irrigation, and rainwater harvesting. The amount of supplemental irrigation should reflect the water needs of the plants and the natural amount of rainfall in the area. (In short, don't give a plant more water than it needs!) However, no matter what irrigation method is chosen, watering late at night or early in the morning eliminates most of the water lost due to evaporation.

Flood Irrigation

For more than three centuries, farmers in New Mexico have watered their crops using flood irrigation. Water is generally diverted from a stream or river into a canal (large ditch) that feeds a series of laterals (smaller ditches) that deliver water to the farm. At the farm, the water passes through the head gate — a gate below the water line that opens and closes to allow water onto the farm. After passing through the farm's head gate, the water is directed into furrows dug by the farmer to help direct it to specific areas, or it is allowed to spread freely over the surface of the field. Large volumes of water are required to force the water to the farthest end of the field. However, fields that have been carefully graded[2] to achieve a level basin or graduated slope[3] allow better control and more uniform application of the irrigation water. The result is more efficient irrigation. Fields that have not been leveled will require a greater depth of water to cover the high and low spots in the field.

Hand Watering

An established landscape designed with low-water-use-plants may need only occasional supplemental watering by hand. This means dragging the hose or carrying a watering can to the desired areas and manually applying the water. A portable sprinkler can also be used at the end of a hose. The best "end of the hose" sprinklers are the ones that deliver water with more uniformity by using larger drops of water to limit evaporation and smaller trajectories to minimize the impact of water blown away by the wind.

Because the rate of water flow can vary greatly, good judgment is required to determine the length of time and the frequency of watering. It is a good idea to run a few tests to determine how quickly water will penetrate the soil. Also, beware of the main problem with manually controlled hoses or hose-end sprinklers: they can waste a tremendous amount of water when the faucet is left on by mistake.

Automated Sprinklers

Automated sprinklers are one of the most efficient ways to deliver uniform water to turf areas. These systems apply measured amounts of water over large areas by allowing the user to choose such variables as the time of day that watering begins, how long watering will continue, and the number of days per week or month that watering occurs.

To determine how much water is being delivered by sprinklers, try the "catch can" test. Place cans throughout the yard and turn on the sprinklers for five to 10 minutes. Then

Background Information: Irrigation Practices (continued)

measure the amount of water in each can. This will show you how much water is being applied.

Automated sprinklers usually include buried pipes that bring water to sprinkler heads that pop up out of the ground when the system is turned on. Sprinkler heads vary greatly in the size and shape of the area they cover and the water application rate. So it is important to consider the area to be covered and the plant type to be watered when choosing the type of sprinkler head.

A general rule of thumb is that sprinklers should be placed so that the spacing between them is equal to slightly greater than 100 percent of the radius or 50 percent of the diameter of the area the sprinkler wets. This is called head-to-head coverage and allows an overlap that helps to eliminate dry spots.

Timers for an automated sprinkler system should be adjusted for each season and shut off when it rains. Some of the newer automated systems have sensors that shut the system off when it rains, the humidity increases, or it's too windy for efficient irrigation. For optimum efficiency, automated systems should be checked on a regular basis for malfunctioning sprinkler heads, blocked water lines, leaks, and other potential problems.

It is tempting with automated sprinklers to set the timer and forget about it. In most cases this leads to over-watering. Remember, an automated system is only as efficient as the person who operates and maintains it.

Drip Irrigation

Drip irrigation is a slow, controlled application of water to the soil, which helps maintain uniform soil moisture around plants. Because drip systems minimize water lost to evaporation and wind drift, they use 30 to 50 percent less water than other irrigation methods. Drip lines and emitters sit on top or just under the surface of the soil, therefore a drip irrigation system is usually not as expensive to install as an underground sprinkler system.

With a drip system, water oozes onto the soil through emitters or pre-punched holes in narrow water lines, placing the water directly into a plant's root zone. Emitters come in "flow rates" so that the amount of water discharged each hour can be carefully matched to the size, type, and water requirements of each plant. For example, drip emitters are available in one gallon per hour, two gallons per hour, and four gallons per hour designations. The one-gallon-per-hour emitter would be appropriate for a low-water-use plant. A four-gallons-per-hour emitter would be more appropriate for a moderate-water-use plant.

Drip systems are relatively easy to install, and they can be hooked into existing irrigation systems or attached onto hose bibs. They can be either automated or manual. Like other types of irrigation systems, drip irrigation will not save water if it is improperly used. A drip system must be checked regularly for leaks and needed repairs. Automated drip systems must be adjusted for weather and seasonal changes, and the system should be run only when, and for as long as, the plants need water.

Rainwater Harvesting

Water harvesting—the process of collecting or directing rainwater to meet landscape needs—is a good way to maximize the use of natural rainfall and reduce supplemental landscape irrigation. One of the best ways to collect rainwater is to divert or gather the water that runs off the roofs of buildings or from hardscaped[4] areas. A quarter inch of rain falling on a 1,000-square-foot roof can yield 150 gallons of water!

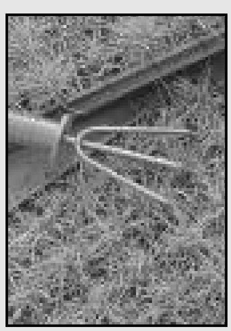
Background Information: Irrigation Practices (continued)

The simplest rainwater harvesting techniques are called "passive" because the water is simply redirected using the force of gravity. Rainwater flowing from a roof, driveway, or sidewalk can be directed toward landscaped areas using berms (small hills). Shallow depressions filled with cobblestones at the end of gutter downspouts will allow rainwater to pool. This pooled water can then be directed toward plants through swales (depressions in the soil, similar to streambeds).

A more complex or "active" harvesting system might include storing captured rainwater. Storage facilities can be below-ground cisterns or aboveground rainbarrels or tanks. The water from these storage areas can either be gravity fed or pumped to plants. (The City of Albuquerque has published an excellent guide to rainwater harvesting. See Appendix F for ordering instructions.)

FINAL THOUGHT

With any irrigation system, the homeowner must decide when to irrigate and how much water to apply. An experienced gardener can tell if he or she needs to water by taking a small soil sample and feeling it. The rest of us probably need to learn to look at plants more carefully to determine their water needs. (If a plant is still wilted in the early morning before the sun hits it, or if recent footprints are visible in the grass, it may be time to water.) The general rule of thumb is that watering less often and more deeply will encourage deeper rooting and more efficient use of water. However, certain soil conditions may warrant adjustments in this practice. **Chapter Five: Appropriate Turf Areas** goes into detail regarding varying soil types and watering methods.



Emerging Technology

Irrigation technology is constantly improving. Soil moisture sensors, which measure the moisture content of the soil, are now available to help determine when plants need supplemental water. For classroom experiments, a very simple moisture sensor is a piece of clay pottery placed into the soil. The clay changes color when it's wet. Clay sensors can also be found in the shape of a "cartoonish" worm sold in local nurseries, or simply use a broken piece of pottery (but be careful of sharp edges).

One of the latest technologies is subsurface drip irrigation, which places drip emitters and tubing underground next to the roots of the plants. Subsurface irrigation is currently being tested on turf and agricultural crops. One problem with subsurface irrigation is that prairie dogs sometimes chew through the tubing to get a free drink. See if the students can come up with some solutions to this problem. For more information on subsurface irrigation and emerging irrigation technology, contact the local county extension service office. See Appendix B for area phone numbers.

TEACHER NOTE: Be sure to discuss zoning principles with the students. See page 16 for an explanation of zoning.

FOOTNOTES (PAGES 86, 88, 89)

[1] Berm – a mound or wall of earth used in landscaping to direct or contain water

[2] Grading is the process of raking or rearranging the soil to provide an even distribution of water.

[3] A graduated slope or slight decline of two or three degrees down from the head gate will allow the water to reach the far end of the field more quickly, requiring less water. However, graduated slopes that are too steep may cause the water to advance too fast, resulting in inadequate wetting of the root zone, increased soil erosion, and runoff at the bottom of the field. The soil type will determine the appropriate grading.

[4] Hardscape – any non-permeable surface in a landscape, such as sidewalks, patios and porches

Problem to Solve: Harrison & Siebert Irrigation Project

Your landscape company is working on a bid for an irrigation job.

Pick either the Harrisons' house or the Sieberts' house. Create an irrigation plan for the house. Consider rainwater harvesting, hose-end (or hand) watering, automatic sprinkler systems and drip systems. Use what you know about irrigation from the activities, the background information, and any additional information your teacher gives you. Write a letter or create drawings of the yard that clearly state your recommendations for the type of irrigation system they should use. Remember to consider their family needs in giving your advice. You can suggest a combination of systems to meet the needs of different areas of the yard. Be sure to give your reasons for the choices you make.

The Harrisons' House. The Harrisons are an older couple. They travel out of town for extended periods of time. In the front yard they have grass, shrubs, and trees. They like to plant seasonal flowers in the bed in the corner (created by the house and the garage). They enjoy pansies all winter, marigolds and zinnias in the summer, and a new color of chrysanthemum each fall. They like the lawn green at all times in both the front and the back yards. In the back yard, they also have an apple tree, a pear tree, and a plum tree. Under the fruit trees they have a groundcover called Vinca, which grows quickly all summer and is dormant in the winter.

The Sieberts' House. The Sieberts have two children and two dogs. The dogs have the run of most of the back yard. The front yard is xeriscaped with native shrubs, perennials, and a beautiful grouping of desert willows. The entire area is mulched with medium-sized bark. There is no landscape cloth or black plastic under the mulch.

In the back yard, the Seiberts have a buffalograss lawn. They also have a large rose and flower garden that has 15 rose bushes in it. This area is fenced off from the dogs. Under the trees in the backyard they have put in finely ground gravel which packs down to make a hard surface that absorbs water well and only gets occasional infestations of weeds.

Their large house has a metal roof but no rain gutters.

Harrison & Siebert: Project Cover Sheet

Pick either the Harrisons' house or the Sieberts' house. Create an irrigation solution for the house you select. Consider flood irrigation, hand or manual watering, automatic sprinkler systems, drip systems, and rainwater harvesting. Use what you know about irrigation from the activities, the background information, and any additional information your teacher gives you. Write a letter and/or submit detailed illustrations that clearly explain to the household members what type of irrigation system and watering methods they should use. Remember to consider their individual situations in giving your advice.

You can suggest one system for the entire yard or a combination of systems. Your goal is to create a workable system that meets the needs of the plants in a particular area. Be sure to give your reasons for the choices you make.

If you are required to complete Level 2, you will need to get prices for the components of your designed system.

Level 1:
Your completed project should include:

_____ Moving Water Around Student Worksheet

_____ Water Around My School Site Plan

_____ Too High, Too Low, Just Right Student Worksheet

_____ Design-a-Drip Student Worksheet

_____ Rainwater Harvesting Student Worksheet

_____ Letter and/or drawings to the homeowner

Level 2:
Your completed project should also include:

_____Drawing of the site with a diagram of the proposed irrigation system

_____Cost analysis of the proposed system

Harrison & Siebert: Tips For Getting Started

Follow the outlined steps to help you get started on your project.

1. Choose either the Harrison or Siebert landscape.

2. Draw a simple schematic of how you think the landscape looks. Be sure to include all of the information provided in the description.

3. Draw a line around areas that can be grouped together for irrigation purposes. These areas should contain plants that have similar watering needs and are close to each other.

4. Using what you have learned in the activities and background reading, choose an irrigation type for each of the grouped areas. Your options include: flood irrigation, hand watering, automated sprinklers, drip irrigation, and rainwater harvesting.

5. On the back of your drawing write an explanation for each irrigation system you chose.

6. Write a letter that explains to the homeowner how the landscape has been grouped and which type of irrigation you recommend for each group. Be sure to include an explanation of WHY you choose the irrigation system. Include your drawing with the letter.

When To Water

In arid areas such as New Mexico, most landscapes need extra water above and beyond the naturally occurring rainfall. This is especially true during the hottest months when landscape plants can die if they do not receive additional water. That's why it makes sense to include an irrigation system in a landscape. If used properly, an irrigation system will save time and help keep plants healthy. A well-planned and well-maintained irrigation system can significantly reduce the amount of water needed to keep a landscape healthy. The trick is to pick the right irrigation system to suit the lifestyle of the property owner and the plants in the landscape.

In order to determine what irrigation system will be the most effective for your landscape, you will need to research the five main irrigation methods that are used in New Mexico: flood irrigation, hand watering, automated sprinklers, drip irrigation, and rainwater harvesting.

No matter what irrigation system you choose, there are basic rules to follow:

- Always water either early in the morning or late at night to eliminate waste due to evaporation.
- Never allow excess water to pool or run off of your desired application area.
- Maintain your system to prevent leaks and broken equipment from improperly applying water.

Flood Irrigation

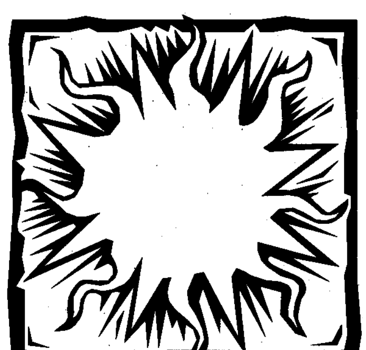
New Mexicans have been practicing flood irrigation for more than three centuries. It is the tradition of using an acequia or ditch system to deliver water to fields. The acequia system was introduced by the Spaniards and incorporated by native New Mexicans because of its effectiveness and ease of use. Water is generally diverted from a stream or river into a canal (large ditch). The canal feeds a series of laterals (smaller ditches) that are adjacent to the fields. The water passes from the lateral onto the field through the head gate. The head gate is a solid metal gate below the water line of the lateral ditch that opens and closes, controlling the flow of water onto the farm. The river water then floods over the fields irrigating the crops. The farmer either allows the water to evenly cover the field or directs the water to specific areas through furrows or small grooves dug in the soil.

How does the water get from the head gate to the other end of the field?

Those farmers and homeowners who are lucky enough be adjacent to the acequia system and have the water rights to it are the only ones who get to use the acequia for flood irrigation. Other means of irrigation are more accessible to the majority of homeowners.

Hand Watering

Hand watering involves dragging a hose or carrying a watering can to the areas in need and manually applying the water. This system requires the most manual labor but is also the least expensive. If you have an established landscape that has been designed with low-water-use plants, you may only have to water occasionally and can go without the cost of an expensive irrigation system.



How could the wind and sun affect the use of sprinklers when watering the lawn?

When To Water (continued)

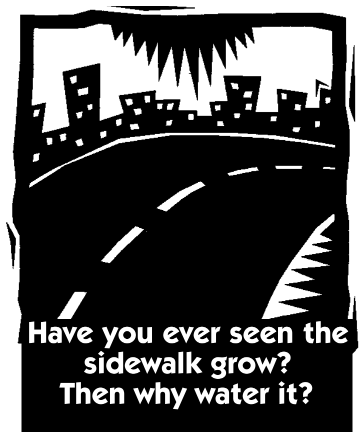
Hand watering also includes the use of a sprinkler at the end of a hose. The best "hose-end" sprinklers are the ones that deliver water in large, uniform drops over short distances. This limits the rate of evaporation and the potential impact of the wind. (Try not to use any sprinkler system when it is windy. The water will get blown off your desired location.)

Automated Sprinklers

Automatic sprinkler systems are one of the most efficient ways to deliver uniform water to turf (lawn) areas. These systems usually include buried pipes that bring water to sprinkler heads, which pop up out of the ground when the system is activated.

Sprinkler systems usually have automated timers that control the time of day the system will turn on and how long it will water. Timers for automated irrigation systems should be adjusted for each season. For example, in the cooler autumn months, a landscape doesn't need as much water as during the hot, dry month of June. Therefore, sprinklers don't need to run as long during October as they do in June. Sprinklers should also be adjusted for weather conditions. They should be turned off when it rains or it is too windy for them to be effective. In addition, most controllers need to be reset if the electrical supply has been interrupted.

Just like every other irrigation system, automated sprinkler systems need to be checked regularly to make sure they are functioning properly and watering only the appropriate areas. It is tempting to set an automatic sprinkler timer and then forget about it. In most cases this leads to over-watering. Remember, an automated system is only as efficient as the person who operates and maintains it.



Drip Irrigation

Drip irrigation uses a slow, controlled application of water to the soil. Water runs through small hoses and oozes out emitters or pre-punched holes in the hose directly into the soil at the plant's root zone. Because the water is placed directly at the plant's root, drip irrigation can use 30 to 50 percent less water than other watering methods. Perhaps best of all, drip irrigation helps to maintain a uniform soil moisture around plants, which optimizes plant growth and minimizes water loss.

The emitters control the amount of water released from the holes in the pipes and come in various styles and flow rates that will let you tailor the amount of water discharged and the size of the application area. Flow rates are typically measured in liters or gallons per hour. For example, a one-gallon-per-hour emitter might be fine for a small, drought tolerant plant, but a four-gallons-per-hour emitter would be better for a larger, less drought-tolerant plant.

Drip systems are usually inexpensive and relatively easy to install. They can be hooked up to a hose bib or connected to a series of pipes buried underground like the automated sprinkler system. Drip systems can be turned on manually or attached to a timer for an automated system. Drip systems need regular maintenance and seasonal adjustments to the timer. Just like hand watering and automated sprinklers, the drip system is only as efficient as the people running the system.

When To Water (continued)

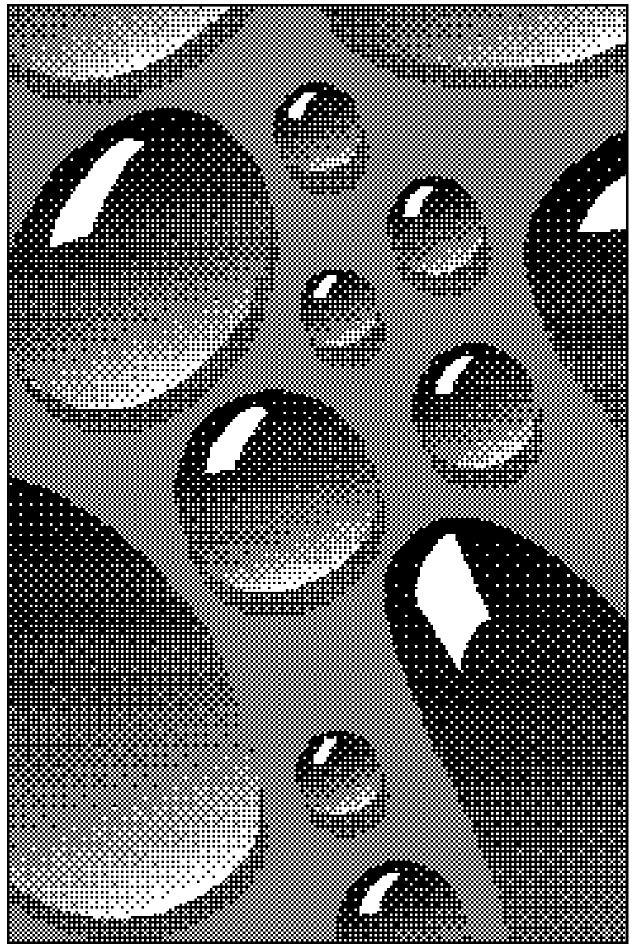
How can you use the rainwater that comes off the roof? From what other surfaces does rain run off?

Rainwater Harvesting

Water harvesting is the practice of capturing rainwater and directing it to where it is needed or storing it for future use. Rainwater harvesting is a great way to utilize all the natural rainfall at a site. One of the best ways to collect rainwater is to grab it as it runs off the roofs of buildings. A quarter inch of rain falling on a 1,000-square-foot roof can result in 150 gallons of stored or diverted water.

Directing or diverting rainwater to specific areas on the ground by using depressions and berms (small hills or mounds) is very effective, but the key is keeping the distances short so water isn't lost in transport. For example, a shallow depression, similar to a streambed, could be dug to lead water from a roof gutter or a hillside to a fruit tree. A small berm on the downhill side of the fruit tree would help contain the water long enough for it to soak into the ground.

If you would like to use a more complex or active rainwater harvesting system, include storage and pumping of the collected water. Cisterns or large rain barrels are great for storing rainwater, and then the stored rainwater can be pumped through drip or sprinkler systems onto your plants.



Final Thought

With any of these irrigation systems, you must decide when to irrigate and how much water to apply. An experienced gardener can tell if he or she needs to water by taking a small soil sample and feeling it. The rest of us probably need to learn to look at plants more carefully to determine their water needs. If a plant is still wilted in the early morning before the sun hits it, or if you can see your footprints in the grass, you may need to water.

Charts & Graphs

Selection, Number, and Spacing of Emitters

The following chart provides information on emitters for a drip irrigation system. It provides recommendations on emitter placement, number of emitters per plant, and the emitter rate in gallons per hour (gph).

Plant	Flow Rate (gph)	Number of Emitters or Orifices	Placement of Emitters
Low shrubs (2-3 feet)	1.0	1	at plant
Shrubs and trees (3-5 feet)	1.0	2	6-12 inches either side
Shrubs and trees (5-10 feet)	2.0	2-3	2 feet from tree equally spaced
Shrubs and trees (10-20 feet)	2.0	3-4	3 feet apart equally spaced
Shrubs and trees (20 feet or higher)	2.0	6 or more	4 feet apart equally spaced
Containers (Potted plants)	0.5-1.0	1	at plant
Flowerbeds	1.0	1	at plant
Groundcover	1.0	1	at plant
Vegetables (closely spaced)	0.5-1.0	1	every 16-24 inches
Vegetables (widely spaced)	1.0-2.0	one per plant	at plant

To convert measurements to metric, see Appendix N.

Table from “Efficient Use of Water in the Garden and Landscape”, Jerry Parsons, et. al., The Agriculture Program of the Texas A&M University System, 1997.

Moving Water Around

Main Question:
How do irrigation systems work?

Objectives:
- To describe and simulate the three main types of irrigation systems: flood, sprinkler, and drip
- (Optional) To introduce new technology, subsurface drip irrigation

Subjects: science, math

Time: 1-hour demonstration after setup

Vocabulary:
flood irrigation, furrow irrigation, drip irrigation, soil type, water-holding capacity, saturation, runoff

Advance Preparation:
- This is designed as a demonstration activity for the whole class.
- When using seeds, set up flats two or three weeks in advance to allow for plant growth. When preparing the subsurface drip flat, be sure to bury the irrigation setup next to the plant seed.
- Prior to demonstration, all plants should receive the same amount of water in the same manner.

Setting the Stage:
- Ask students to describe the different types of irrigation systems that they have seen. Ask them how they would determine what kind of system to use in their yard.
- What are the goals of irrigating?

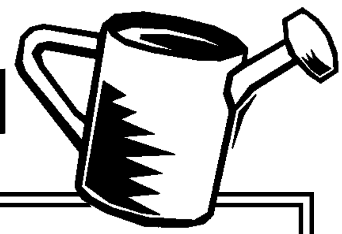
Materials:

4 3 or 4 nursery flats (24” x 24”) with waterproof bases
4 metal or plastic gutter
4 garden watering can
4 garden trowel
4 stopwatch
4 plastic funnel
4 “6-packs” of flower or vegetable seedlings or seed packets
4 modeling clay
4 straws
4 3 graduated cylinders or measuring cups
4 soil
4 water

TEACHER TIPS:
Most plant nurseries will let you have plant flats at no cost. Line flat with plastic wrap to make waterproof.

The activity can be completed without the plants if growing time is not available.

Moving Water Around



A. General Setup

1. Fill the three (or four if demonstating subsurface drip) nursery flats level to the top with soil. Use the same soil mix for each nursery flat.
2. Lightly compress the soil, being careful not to pack it too tightly.
3. Using straws, clay and a funnel, set up a drip irrigation system in Flat 3 as indicated in **Figure 1.** Punch small holes in the straws to simulate drip emitters. (Optional: Repeat drip irrigation setup in Flat 4 and cover the system with soil.)
4. Plant each flat with four rows of seedlings, spaced evenly. In Flats 3 and 4 seedlings should be placed next to the small holes in the straws.
5. If using seeds, allow the plants to grow in the flats for about 2 to 3 weeks. Be sure to keep them moist. All pre-experiment waterings should use the watering can and approximately the same amount of water.
6. Before beginning the experiment, prop up one of the short edges of each flat with bricks or boards. The angle of the flat should be approximately 5 degrees. (On a 24" flat, the top is 2" higher than the bottom.)
7. Position the gutter or catch can under the lower end of the flat to catch the water as it drains off.
8. Place the graduated cylinder in a position to capture the water as it runs off the gutter, or pour the gutter water into the graduated cylinder when drainage is complete.
9. Before beginning the demonstration, give each student a Moving Water Around Student Worksheet to record data onto Experiment Results Table.

B. Flat 1: Simulate Flood Irrigation

1. Place a rolled-up rag along the elevated short edge of the first nursery flat. This will help control the water flow during the simulation.
2. Slowly pour a graduated cylinder of water back and forth across the rag strip at the top of the flat. This simulates the opening of the head gate to allow water onto the field.
3. Time the interval from when the water is applied to the first dribble of drainage into the gutter.

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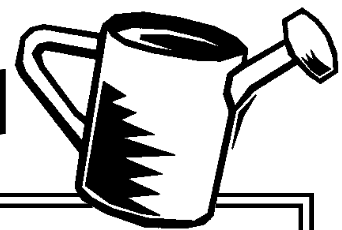
Moving Water Around



4. Record the interval.
5. When the water has stopped draining from the flat, pour everything that has run off into the gutter or catch can into a graduated cylinder.
6. Record how much water has been collected.
7. Allow the water in the graduated cylinder to settle. When the water is clear, measure the volume of soil that has been collected.
8. Label the graduated cylinder and leave for comparison with the next three simulations.

C. Flat 2: Simulate Sprinkler Irrigation

1. Go to the second elevated flat.
2. Starting with a graduated cylinder of water, slowly pour water from a sprinkler can over the flat. Move the sprinkler around the flat, watering all areas.
3. Time the interval from when the water is applied to the first dribble of drainage into the gutter.
4. Record the interval.
5. When the water has stopped draining from the flat, pour everything that has run off into the gutter or catch can into a graduated cylinder.
6. Record how much water has been collected.
7. Allow the water in the graduated cylinder to settle. When the water is clear, measure the volume of soil that has been collected.
8. Label the graduated cylinder and leave for comparison with the other three simulations.

D. Flat 3: Simulate Drip Irrigation

1. Go to the third elevated flat (preset with straws, clay, and funnel).
2. Pour a graduated cylinder of water in the funnel until the plants have been adequately irrigated.
3. Time the interval from when the water is applied to the first dribble of drainage into the gutter.
4. Record the interval.

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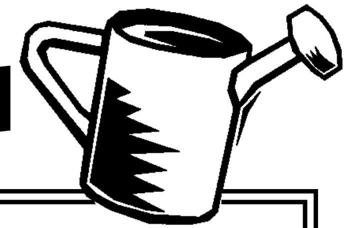
Moving Water Around



5. When the water has stopped draining from the flat, pour everything that has run off into the gutter or catch can into a graduated cylinder.
6. Record how much water has been collected.
7. Allow the water in the graduated cylinder to settle. When the water is clear, measure the volume of soil that has been collected.
8. Label the graduated cylinder and leave for comparison with the other three simulations.

E. Flat 4: Simulate Subsurface Drip Irrigation (Optional)

1. Go to the fourth elevated flat (preset with straws, clay, and funnel attached).
2. Pour a graduated cylinder of water in the funnel until the plants have been adequately irrigated.
3. Time the interval from when the water is applied to the first dribble of drainage into the gutter.
4. Record the interval.
5. When the water has stopped draining from the flat, pour everything that has run off into the gutter or catch can into a graduated cylinder.
6. Record how much water has been collected.
7. Allow the water in the graduated cylinder to settle. When the water is clear, measure the volume of soil that has been collected.
8. Label the graduated cylinder and leave for comparison with the other three simulations.

F. Environmental Effects

1. Repeat the irrigation simulations above while blowing a fan across the flats to simulate the effect of wind.
2. Allow the flats to dry out somewhat (but not enough to wilt the plants). Weigh each flat, then add water according to the above experiments. Put the flats out in the sun and determine how long it takes for each to return to its original weight. This will test the effect of evaporation on land irrigated with the different irrigation systems.

NOTE: Parts D and E and **Figure 1** of Moving Water Around have been adapted from Irrigation Innovation from the Conserve Water Educators' Guide. It is used with permission from Project WET/The Watercourse at Montana State University.

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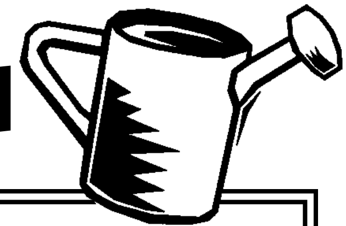
Moving Water Around



Discussion:

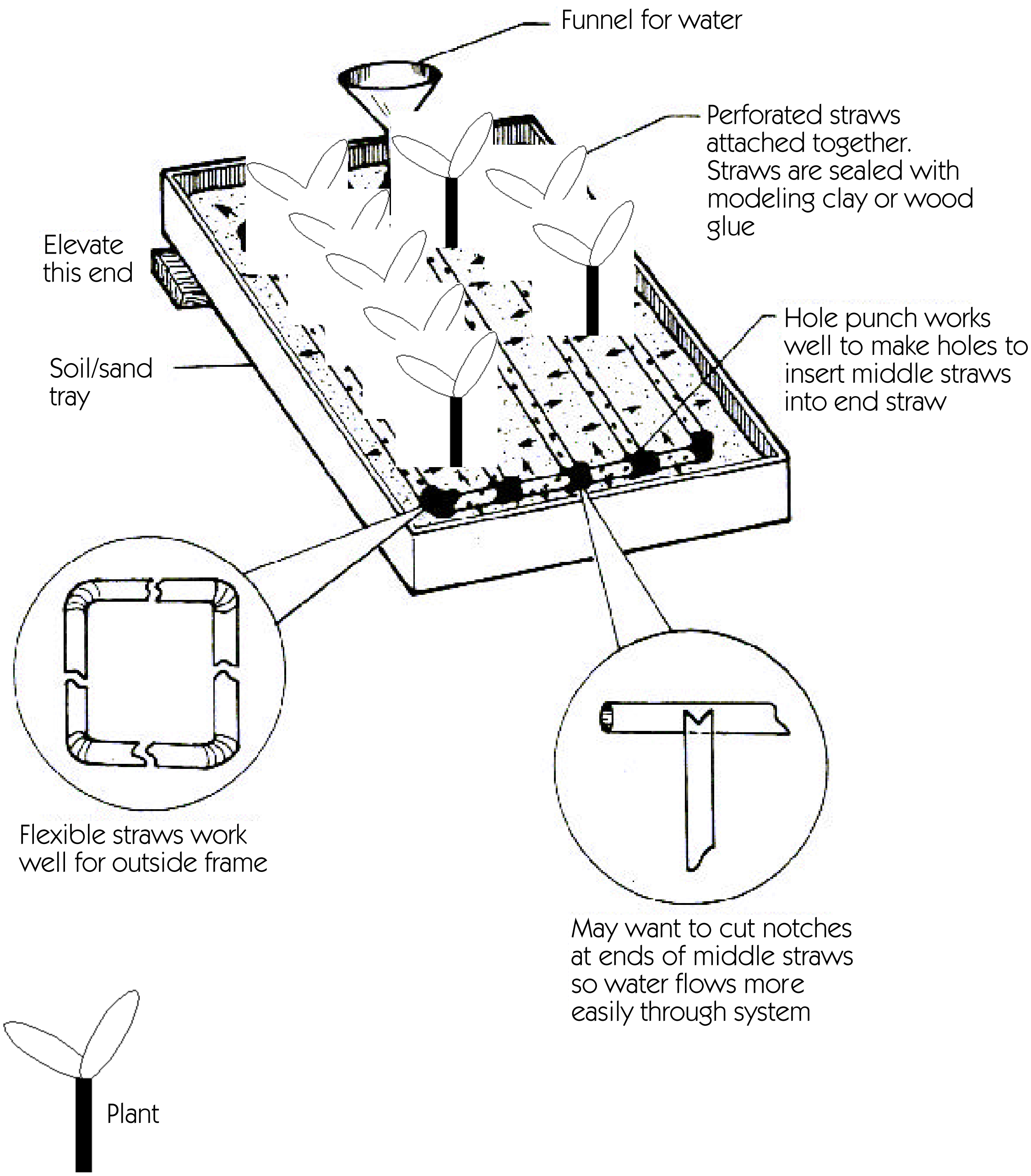
- Discuss advantages and disadvantages of each type of system.
- Which system absorbed the most water?
- Would the same type of irrigation system work for grasses and for individual plants?
- What effect did the fan (wind) have on each of the irrigation systems?
- Would the sun or time of day when watering affect any of these systems?

Extension:

- Use one palette of grass and one palette of plants to determine which irrigation system is best for which type of plant.
- Run experiment comparing sand, silt, and clay soils.
- Run the experiment with different types of mulches around the plants. Is a particular type of mulch more effective with a particular irrigation system?
- Calculate the costs for each system. Include installation costs, cost of labor to operate system, and cost of water.
- Research the history of the use of different types of irrigation systems in the area.
- Put powdered Kool-Aid in the bottom of the nursery flats before adding soil in order to see how deep the water penetrates with each irrigation type. Kool-Aid will appear in the gutter only if the irrigation water has reached the bottom of the flat.

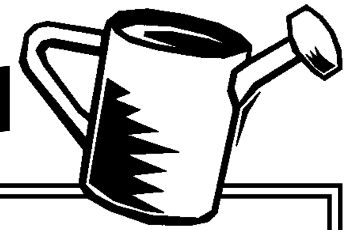
Moving Water Around

Figure 1. Drip System Fabrication



NAME

Moving Water Around

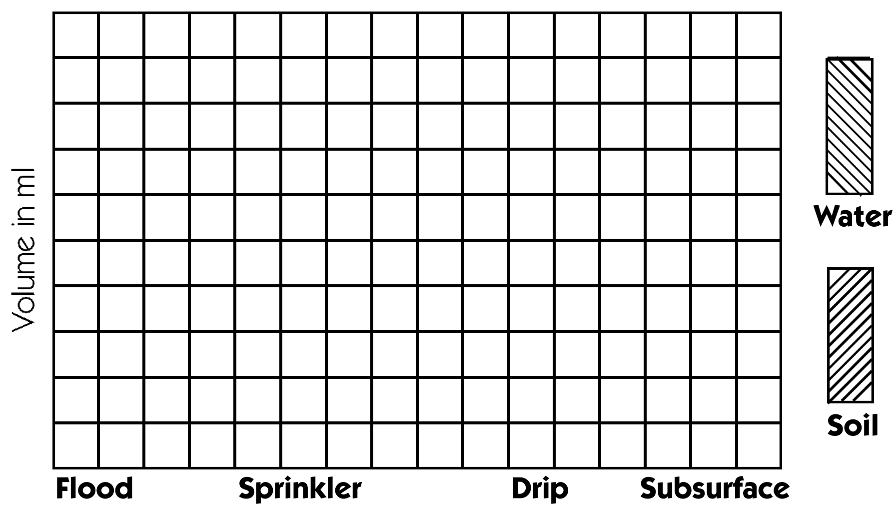


Water Content

Experiment Results Table

Irrigation Type	Time to First Runoff	Vol. of Water Runoff	Vol. of Soil in Runoff
Flood			
Sprinkler			
Drip			
Subsurface Drip			

Use a bar graph to show the volumes of water and soil that ran off from each irrigation system during the experiment.



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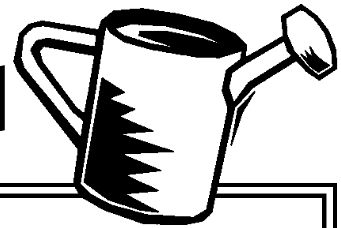
Student Worksheet

NAME

Moving Water Around



1. List advantages and disadvantages of flood irrigation.

2. List advantages and disadvantages of sprinkler irrigation.

3. List advantages and disadvantages of drip irrigation.

4. List advantages and disadvantages of subsurface drip irrigation.

5. If you were raising crops in a field, which system would you choose? Why?

Water Around My School

Main Question:
What kind of irrigation systems does the school use?

Objectives:

- To draw an accurate site plan for the school and calculate the area
- To collect information about the types of irrigation systems used at school and transfer this information to a plan

Subjects: science, math

Time: 1 to $1\frac{1}{2}$ hours

Vocabulary: site plan

Advance Preparation:

- Obtain a schematic drawing of the school plan and size it so that students can use it to record their measurements.
- Divide school property up into zones that will be surveyed by different groups of students.

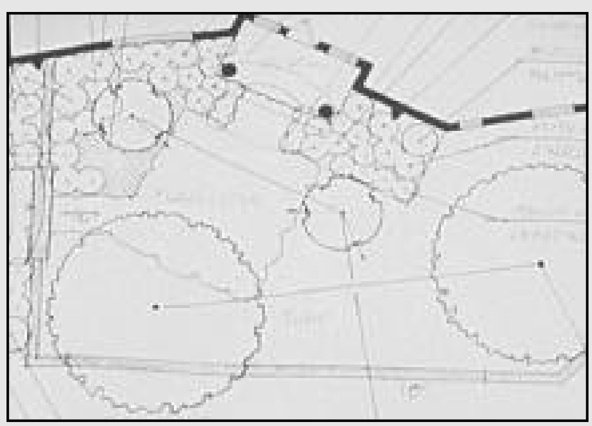
Setting the Stage:

- Review the different types of irrigation systems with the students.
- As a group, design a key for use on a map to indicate sprinklers, drip, flood, and other (if any) irrigation types.

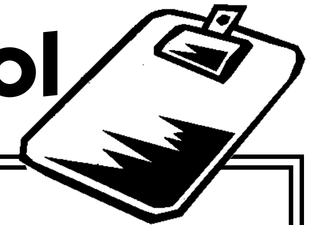
Materials:

4 balls of twine
4 clipboard
4 colored pencils
4 schematic drawing of school
4 masking tape
4 tape measures (optional)
4 permanent markers
4 several cans of the same size

TEACHER TIP:
Activity can be completed in one period if you obtain a scale drawing of the school site plan to give to students for the survey.



Water Around My School



A. School Site Plan

1. Cut several 100-foot lengths of twine. Using masking tape and permanent markers, mark the twine every three feet.
2. Divide students into groups and give each group a section of the school to measure.
3. Each group should include two or three students to measure and one student with the clipboard and site plan to record the data.
4. Send groups out to measure the school.
5. Compile all data that has been gathered and draw a scale drawing of school site. It is easiest to do this on graph paper with a scale (such as 1 square = 5 feet). There are a couple of options for compiling the data.
   a. Put the graph paper on an overhead projector and have each group come up and add their section.
   b. Have each group draw their sections on graph paper and then combine them together by cutting and pasting or overlaying transparencies.
   c. Gather all of the data from each group, make copies of all measurements for the entire class, and have each group draw the whole school property using everyone's data.

B. Irrigation Data

1. Once there is an accurate site plan, walk around the school and observe the types of irrigation systems used. Draw the location of each system on the plan.
2. Calculate the area (length x width) of the site that is being irrigated.
3. In the areas irrigated with sprinklers, set out cans to collect water. On the drawing, show the location of each can.
4. Turn on the irrigation system for 10-20 minutes.
5. Compare the amount of water collected in each can to see how evenly the irrigation system distributes water and the rate at which water is delivered by each system (cm of water/hour).

Extension:

- Report findings to grounds personnel.
- Survey irrigation systems found at home or at a park.
- Research the history of irrigation around the world.

Too High, Too Low, Just Right

Main Question:
How does plant selection affect the amounts of water used?

Objectives:

- To determine the effect of plant selection on irrigation

Subjects: science, math

Time: 1 hour

Vocabulary: soil

Materials:
4 landscape plan (included) 4 calculator

Advance Preparation:

- Make copies of the landscape plan for each student or each group of students.

Setting the Stage:

- Review with students the different costs of using water: monetary, public responsibility, times of drought, ecosystem balance

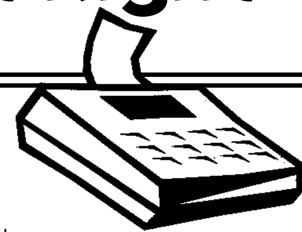
TEACHER TIP
To determine square footage of each area in the Landscape Plan:
- place the Landscape Plan over a sheet of graph paper
- copy the Landscape Plan onto graph paper, or
- copy both the Landscape Plan and the graph paper onto overheads and complete as a class

High Water Use – Tulips

Medium Water Use – Hummingbird Mint

Low Water Use – Texas Red Yucca

Too High, Too Low, Just Right



Calculate Water Use

1. Calculate the square footage of each area in the landscape plan.
2. Determine what materials are found in each area, e.g., trees, groundcover, gravel, etc.
3. Assign each area a high-, medium-, or low-water-use designation according to the plant type. For this exercise, grass is high-water-use, flowers and trees are medium-water-use, and shrubs are low-water-use.
4. Using the table below, calculate the water use for the landscape for one year. (NOTE: This table is an example of water use. It is NOT applicable to all plants and soil types.)

Weekly Water Usage

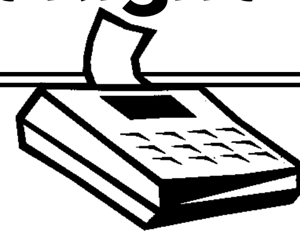
High-Water-Use	Medium-Water-Use	Low-Water-Use
20 gallons added per square foot every week for 20-week summer season	10 gallons added per square foot every week per 20-week season	3 gallons added per square foot every week per 20-week season
12 gallons added per square foot every week for 16-week pre- and post-summer season	6 gallons added per square foot every week for 16-week pre- and post-summer season	2 gallons added per square foot every week for 16-week pre- and post-summer season
10 gallons added per square foot every week for the remaining 16 weeks of the year	2 gallons added per square foot every week for the remaining 16 weeks of the year	1 gallon added per square foot every week for the remaining 16 weeks of the year

Extension:

- Re-classify the zones, putting in more low- and medium-water-use areas and fewer high-water-use areas. How does that affect the total water usage?
- Categorize plants around the school according to water usage and estimate exterior water use for the school. Get a copy of the water bill from the school district to see actual use.
- Calculate water use for the school with low-water-using plants.
- Categorize plants around the home according to water usage. Estimate water use for the landscape. Compare the water bills for summer and winter to see actual use.

NAME

Too High, Too Low, Just Right



1. High-Water-Use

Zone	Material or Plant Type	Square Feet	Water used per year
Total	———-		

2. Medium-Water-Use

Zone	Material or Plant Type	Square Feet	Water used per year
Total	———-		

3. Low-Water-Use

Zone	Material or Plant Type	Square Feet	Water used per year
Total	———-		

4. What is the total water used for the whole landscape every year?

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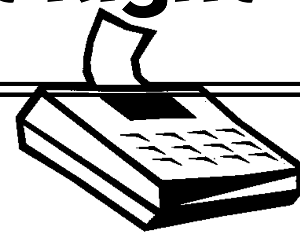
Too High, Too Low, Just Right



Equations

High-water-use

(20 gallons/square foot x square footage of area)/week x 20 weeks
+ (12 gallons/ square foot x square footage of area)/week x 16 weeks
+ (10 gallons/ square foot x square footage of area)/week x 16 weeks
Total gallons used

Medium-water-use

(10 gallons/square foot x square footage of area)/week x 20 weeks
+ (6 gallons/ square foot x square footage of area)/week x 16 weeks
+ (2 gallons/ square foot x square footage of area)/week x 16 weeks
Total gallons used

Low-water-use

(3 gallons/square foot x square footage of area)/week x 20 weeks
+ (1 gallons/ square foot x square footage of area)/week x 16 weeks
+ (0 gallons/ square foot x square footage of area)/week x 16 weeks
Total gallons used

Example

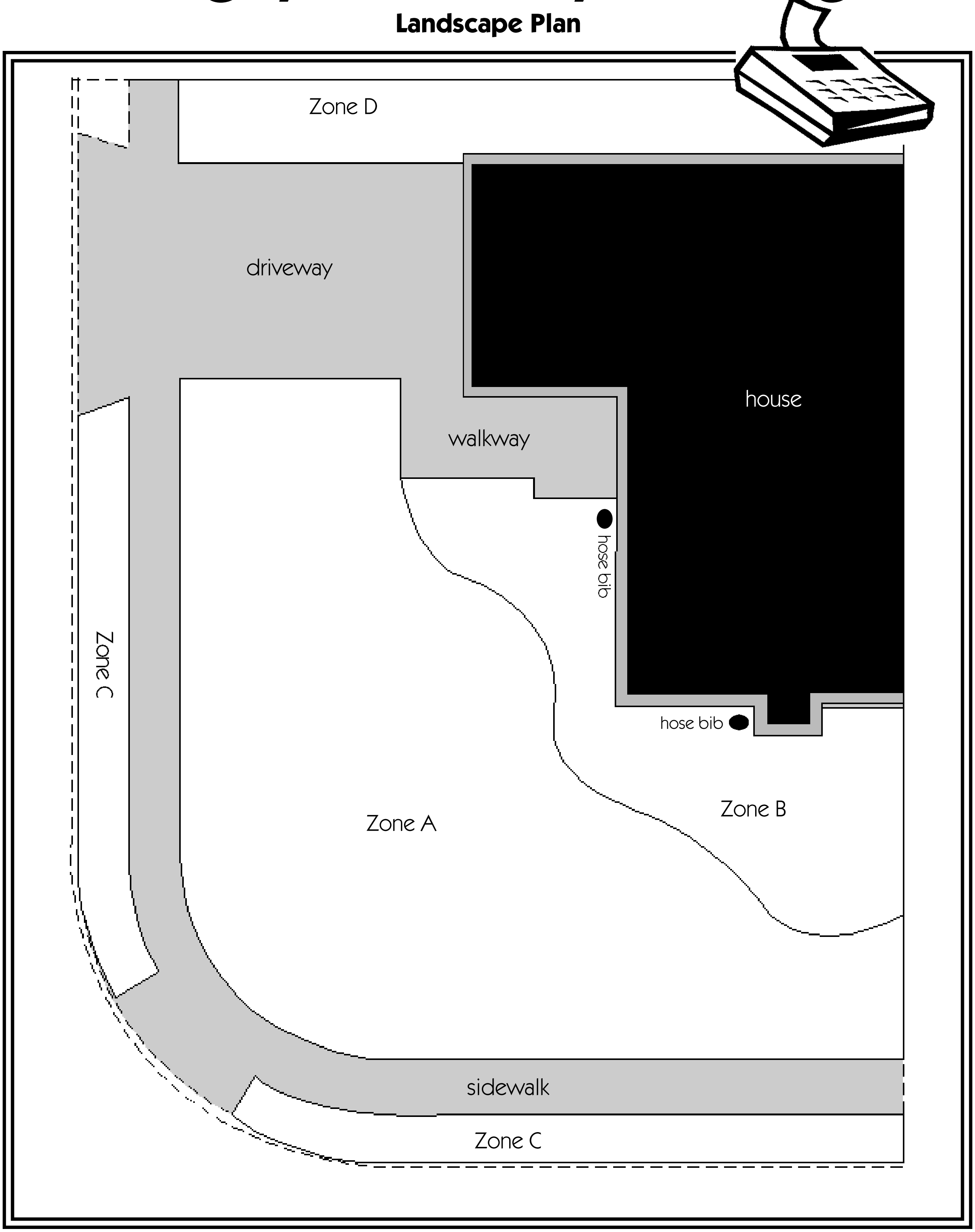
A high-water-use area of 10 square feet:
(20 gallons x 10 square feet x 20 weeks) + (12 gallons x 10 square feet x 16 weeks) +
(10 gallons x 10 square feet x 16 weeks) = 7520 gallons per year

A medium-water-use area of 10 square feet:
(10 gallons x 10 square feet x 20 weeks) + (6 gallons x 10 square feet x 16 weeks) +
(2 gallons x 10 square feet x 16 weeks) = 3280 gallons per year

A low-water-use area of 10 square feet:
(3 gallons x 10 square feet x 20 weeks) + (1 gallons x 10 square feet x 16 weeks) +
(0 gallons x 10 square feet x 16 weeks) = 760 gallons per year

Too High, Too Low, Just Right

Landscape Plan



Design-a-Drip

Main Question:
How does an integrated (drip and sprinkler) irrigation system work?

Objectives:
- To zone a landscape plan
- To design appropriate drip system
- To calculate installation and operating costs

Subjects: science, math, art

Time: 2 hours

Vocabulary:
drip irrigation, bubbler, micro-sprayer, drip emitter, t-connection, micro-tubing, mini-sprinkler, end cap, timer, sprinkler, zone, groundcovers

Advance Preparation:

- Review information about the design and installation of irrigation systems from the City of Albuquerque booklet, "Low Volume Irrigation."

Setting the Stage:

- Explain to students the concept of zoning a landscape and review the various types of irrigation systems and when each would be used.

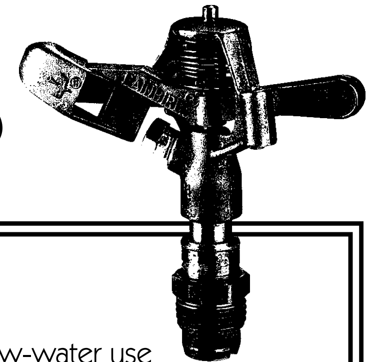
- Review with students the components of a drip irrigation system. (See the Additional Resources section at the end of this chapter for catalog and website information.)

Materials:

4 landscape plan (Figure 1)
4 ruler
4 string
4 calculator (optional)
4 colored pencils (optional)
4 catalog for drip irrigation

TEACHER TIP:
To challenge students, give them a design budget, such as $200 (tight); $800 (medium); or $1,200 (generous).

Design-a-Drip



A. Irrigation Design

1. Using the attached Landscape Plan, assign high-, medium-, or low-water use to each landscape zone.
   For this exercise, grass is high-water-use, flowers and trees are medium-water-use, and shrubs are low-water-use.
2. Research the various components available for irrigation systems.
3. Design and draw an irrigation system to fit the landscape plan.
4. Exchange plans with other students and evaluate their plans.

B. Calculating Installation Costs

1. Measure the length of drip lines using string and ruler.
2. Total the number of items used in the irrigation system and calculate costs based on the unit costs given in Table 1, or research the costs from a local supplier.

C. Calculating Operating Costs

1. Complete the information on Tables 1 and 2. Use information found on the Internet or from an irrigation supply center.
2. Using the information in Table 2, calculate the water cost of irrigating the landscape for one month; for a growing season (5 months).

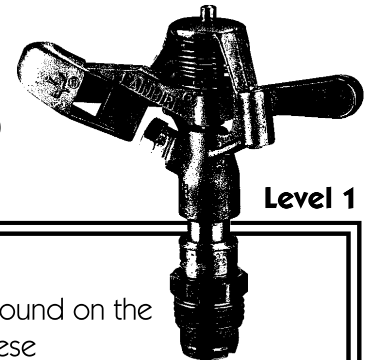
Extension:

- Modify the landscape to decrease installation costs; to decrease operating costs.
- Add rainwater harvesting from roof; see City of Albuquerque's "Rainwater Harvesting Guide." or Activity 3-5 Rainwater Harvesting.

NAME

Student Worksheet

Design-a-Drip



Level 1

Table 1 includes components of an irrigation system. Use information found on the Internet or from an irrigation supply center to discover how each of these components works in a landscape. Decide which of these components and how many of each you will need for your landscape, **Figure 1.** Complete the information on Table 1. Feel free to delete components or include components that have not been listed.

Table 1: Equipment Costs

Item	Cost per Item	Gallons per Hour (GPH) of Water	Distribution	Number/ Amount Needed	Total Cost
Example: Main Drip Line	$6.50/50 ft.	——-		200 ft.	$26.00
Main Drip Line (usually 1/2" to 3/4")	$6.50/50 ft.	——-			
Micro Tubing (secondary drip line, usually 1/4")	$3.25/50 ft.	——-	——-		
Drip Emitter	$0.20 each	2 GPH	——-		
Adjustable Sprayer	$0.58 each	17 GPH	5 ft. radius		
Sprinkler Head	$0.90 each	34 GPH	11 ft. radius		
Mini-Sprinkler	$0.20 each	6.8 GPH	3 ft. radius		
End Cap	$0.25 each	——-	——-		
T-Connection Micro Tubing (splitter)	$0.20 each	——-	——-		
Timer	$80.00 each	——-	——-		
Total Equipment Cost	———	———	———	———	

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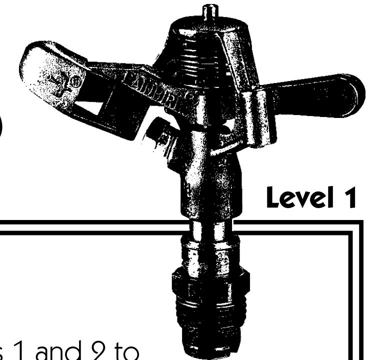
Student Worksheet

NAME

Design-a-Drip



Level 1

Table 2: Operating Cost

Research the water costs in your area and use the information in Tables 1 and 2 to calculate the cost of irrigating the landscape. You will have to estimate the operating time (how long you will water). Operating times are determined by plant and soil type.

Number/Amount and Item	Gallons per Hour	Normal Operating Time	Cost of Water	Cost for One Month	Cost for Growing Season (5 Months)
Example: 20 Mini-Sprinkler Head	5 GPH	8 hours per month	$2.50/1000 gallons	$2.00	$10.00
Total Operating Cost	——	——	——		

<u>For this exercise only:</u>
High-Water-Use Areas require 50 gallons per month
Medium-Water-Use Areas require 25 gallons per month
Low-Water-Use Areas require 8 gallons per month

1. What is the **total** cost of installing the irrigation system?

2. What is the **total** water cost of running the irrigation system for one month?

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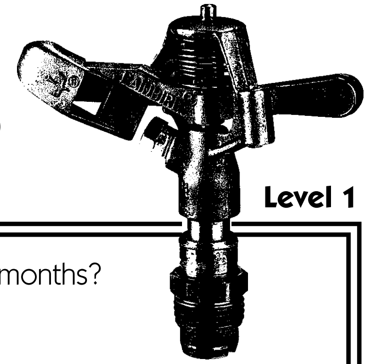
NAME

Design-a-Drip



Level 1

3. What is the **total** water cost of running the irrigation system for five months?

4. Did you think this was a lot of money to spend on irrigation equipment? Why or why not?

5. What did you find out about water costs in your area?

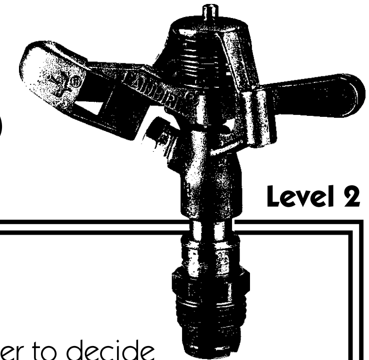
6. Is the water cost in your community too high or too low?

7. How much should water cost? Explain your answer.

NAME

Student Worksheet

Design-a-Drip



Level 2

Use information found on the Internet or from an irrigation supply center to decide which irrigation components will be required to irrigate your landscape. Complete the information on Tables 1 and 2.

Table 1: Equipment Costs

Item	Cost per Item	Number/Amount Needed	Total Cost
Example: Main Drip Line	$6.50/50 Ft.	200 Ft.	$26.00
Total Equipment Cost	———	———	

(continued on next page)

Design-a-Drip

Level 2

Table 2: Operating Cost

Research the water costs in your area and use the information in Table 1 and 2 to calculate the cost of irrigating the landscape. You will have to estimate the operating time (how long you will water). Operating times are determined by plant and soil type.

Number/Amount and Item	Gallons per Hour	Normal Operating Time	Cost of Water	Cost for One Month	Cost for Growing Season (5 Months)
Example: 20 Mini-Sprinkler Head	5 GPH	8 hours per month	$2.50/1000 gallons	$2.00	$10.00
Total Operating Cost	———	———	———		

For this exercise only:

High-Water-Use Areas require 50 gallons per month
Medium-Water-Use Areas require 25 gallons per month
Low-Water-Use Areas require 8 gallons per month

1. What is the **total** cost of installing the irrigation system?

2. What is the **total** water cost of running the irrigation system for one month?

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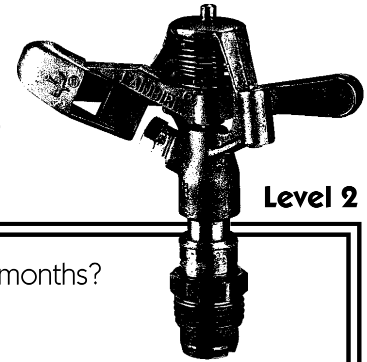
NAME

Design-a-Drip



Level 2

3. What is the **total** water cost of running the irrigation system for five months?

4. Did you think this was a lot of money to spend on irrigation? Why or why not?

5. What did you find out about water costs in your area?

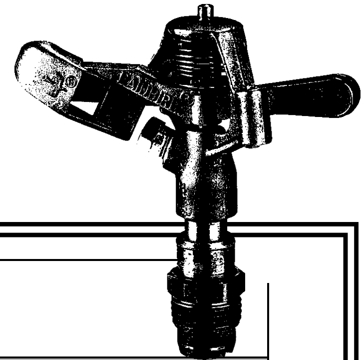
6. Is the water cost in your community too high or too low?

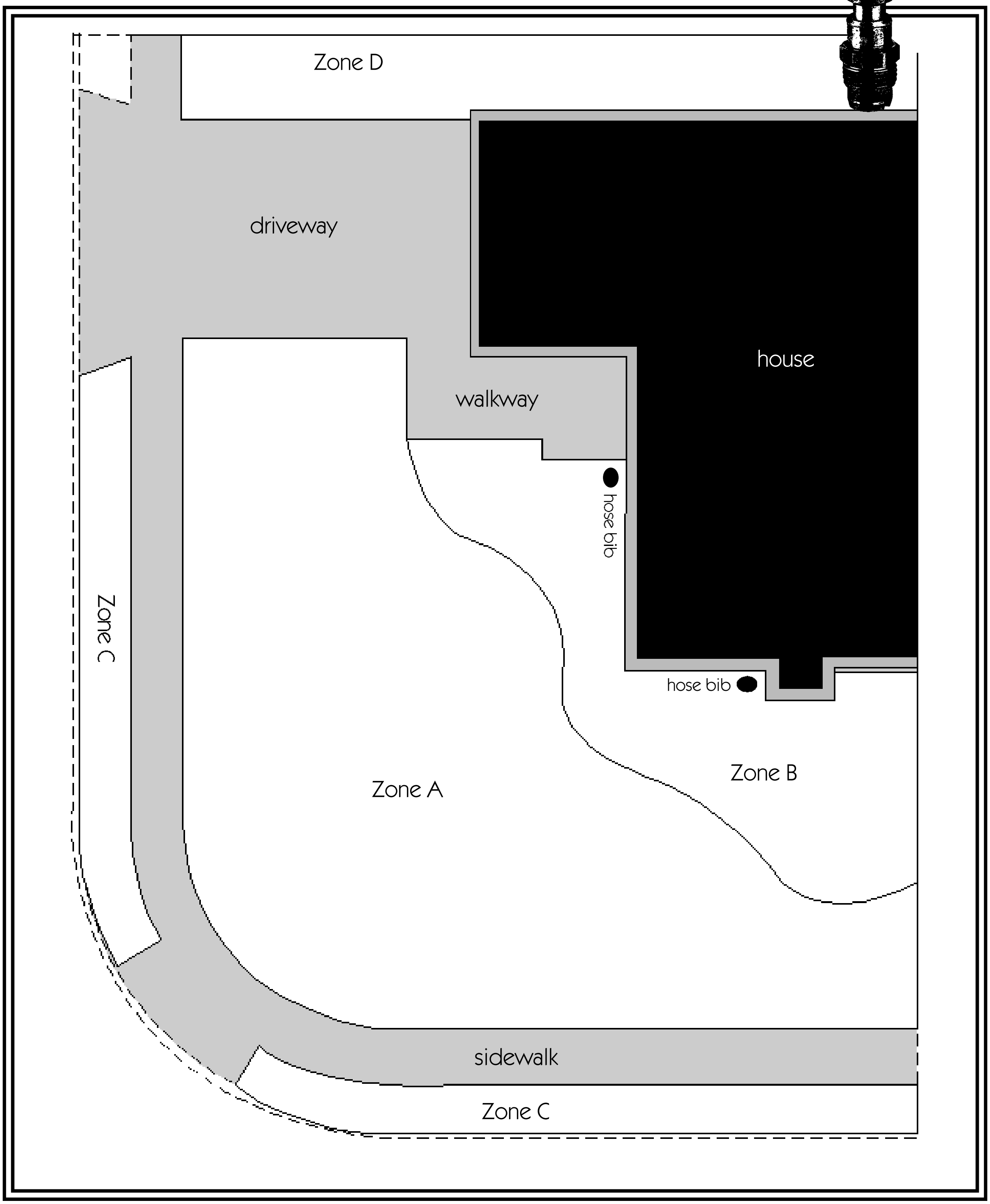
7. What should water cost? Explain your answer.

Student Worksheet

Design-a-Drip

Landscape Plan





Rainwater Harvesting

Main Question:
How does rainwater harvesting work?

Objectives:
- To expose students to the concepts of rainwater harvesting
- To calculate the amount of rain that can be harvested
- To determine the different ways in which rain can be harvested

Subjects: math, social studies, art

Time: 1 to $1\frac{1}{2}$ hours

Vocabulary:
catchment, berm, runoff, cistern

Advanced Preparation:
None

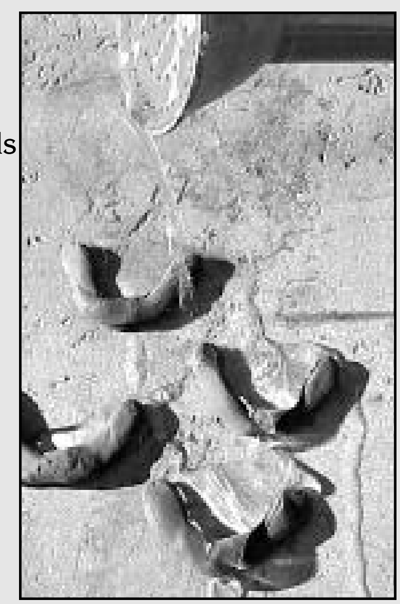
Setting the Stage:

- Discuss how families obtained their water before public water supplies and acequias.
- Discuss rainfall averages for the area. (See Appendix C for monthly averages in various areas across New Mexico.)
- Did any of the students' grandparents have cisterns? What areas might still rely on cisterns for their water?

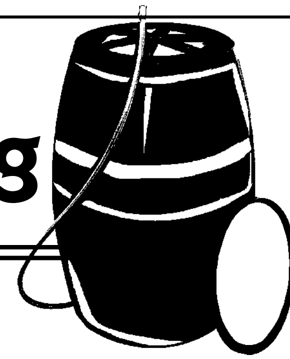
Materials:

4 Monthly Rainfall Data, Appendix C
4 calculator
4 modeling clay
4 small board
4 plastic tub (big enough to fit the small board)
4 Rainwater Harvesting Guide (optional - see Appendix F for ordering a free copy)
4 1 two-inch block
4 watering can
4 water

TEACHER TIP:
Small plastic cutting boards work well for this activity.



Rainwater Harvesting



A. Calculating the Supply

1. Using the rainfall table in Appendix C, enter the annual rainfall for a chosen area into the table on the student worksheet.
2. Multiply the annual rainfall by .623 to convert inches to gallons-per-square-foot. This is a constant number and will not change.
3. Using the information on the student worksheet, calculate the square footage of the roof. Enter the number into the table.
4. Multiply the gallons-per-square-foot from step 2 by the square footage of the roof.
5. Not all of the rain that reaches the roof will run off. The roof material will absorb or evaporate some of the rain. With a metal roof, only 90% runs off, so multiply the gallons of rainwater by .90 to get the total gallons of water harvested.

B. Building a Berm

1. Break into small groups.
2. Place a small board inside a plastic tub. Place a small (1”-2”) block under one end to create slight rise.
3. Roll modeling clay into “snakes” and place them at various positions on the board. Lightly sprinkle water from the watering can over the board to simulate rain. Notice how the modeling clay changes the direction of the water that is running off of the board.
4. Try different placements of the modeling clay to see which are the best shapes and sizes for redirecting and slowing the movement of the water.
5. Draw the best results with explanations onto the worksheet.
6. Discuss how berms could be used in a landscape.

C. Determining Uses

1. In the same small groups, or as a class, discuss the potential uses for rainwater harvesting.
2. Using the Monthly Rainfall Data in Appendix C, determine which months provide rain and during which months there is a deficit of rain. If necessary, repeat the calculations from “Calculating Supply” for the monthly figures. What are some good ways to store the extra water for use in the dry months?
3. In small groups, use the roof diagram to create a plan to catch and contain rainwater for use in a landscape. Decide where high-, medium-, and low-water-use zones might be placed.
4. Draw, model, write out, or present the plan.

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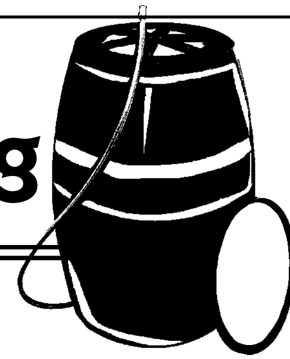
Rainwater Harvesting



Discussion:

- Discuss the advantages and disadvantages of rainwater harvesting.
- Which shapes worked the best for the berms? Can the students think of other ways to slow down or direct rainwater?
- Besides roofs, what would be a good way to collect rainwater?
- Why is rainwater harvesting not more common?
- What would be the impact on the rivers and aquifers if more people used rainwater harvesting?
- How does snowfall figure into rainwater harvesting?

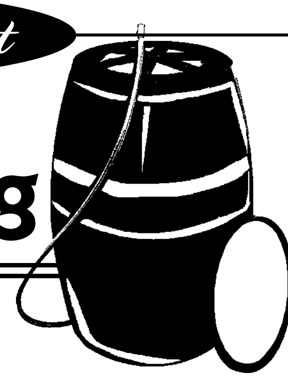
Extensions:

- Calculate water demand using the methods in the City of Albuquerque's Rainwater Harvesting Guide. Compare water supply and demand. Determine if rainwater harvesting will meet part or all of the irrigation needs. If only parts of the irrigation needs are met, create a plan for supplemental supply.
- Build a model of a rainwater harvesting system including cisterns and berming.
- Investigate the use of rainwater harvesting for a potable (drinkable) water supply. Could rainwater be used for drinking? What would have to be done?

Student Worksheet

NAME

Rainwater Harvesting



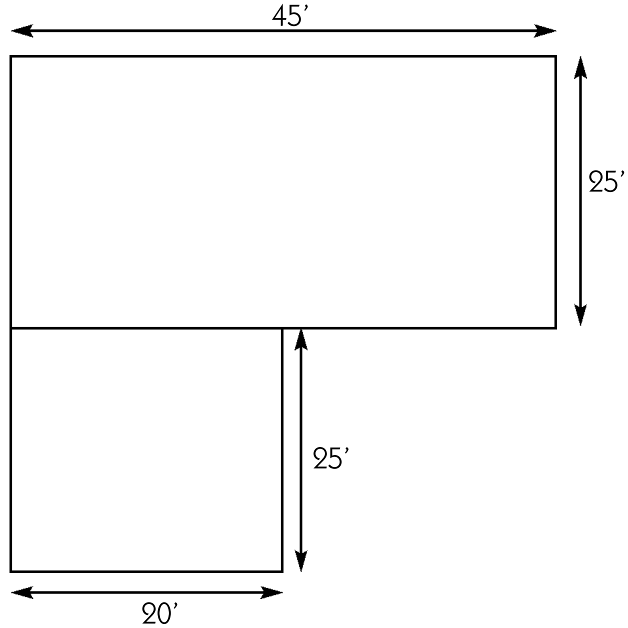
Level 1

Calculating the Supply

1. Using the rainfall table, enter the annual rainfall for the city or town closest to your home. ________inches

2. Multiply the annual rainfall by .623 to convert inches to gallons-per-square-foot. ________ gals. per square feet

3. Calculate the square footage of the roof. ________ square feet



Multiply the gallons-per-square-foot (question 2) by the square footage of the roof (question 3). _______ gallons.

Not all the rain that hits the roof will run off. On surfaces such as metal, some rain will evaporate. On surfaces such as asphalt, some rain will be absorbed.
Multiply the potential gallons harvested (question 3) by 90%, because 10% was either absorbed or evaporated, to get the total number of gallons harvested.

Total rainwater harvested ________ gallons

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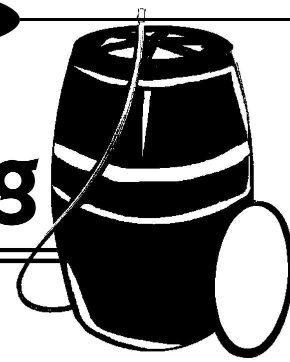
NAME

Rainwater Harvesting



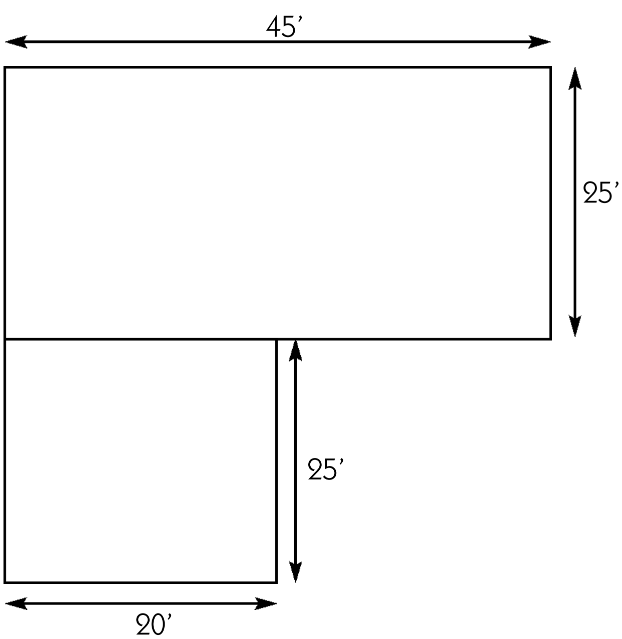
Level 2

Calculating Supply

In the spaces below, list the average rainfall from the table supplied. Be sure to include units of measure.

Annual Rainfall	Convert to Gallons/feet² (multiply by 0.623)	Feet² of Roof Surface	Gross Gallons of Rainfall Per Year	Runoff Coefficient	Total Gallons Harvested Per Year

METAL ROOF



RUNOFF COEFFICIENTS

	HIGH	LOW
Roof: metal, gravel, asphalt, shingles, fiberglass, mineral paper	0.95	0.90
Paving: concrete, asphalt	1.00	0.90
Gravel:	0.70	0.25
Soil: flat & bare;	0.75	0.20
flat & vegetation	0.60	0.10
Lawn: flat & sandy soil;	0.10	0.05
flat & heavy soil	0.17	0.13

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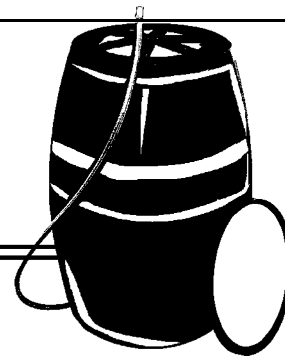
NAME

Rainwater Harvesting



Level
1 & 2

After completing the table, answer the following questions:

1. How much water can be harvested from the roof?

2. How much water could be harvested if the roof measured 65 feet long instead of 45 feet?

3. What does the runoff coefficient represent?

4. Why are there high and low coefficients?

5. What other surfaces, besides roofs, could we use to harvest water? List reasons why your choice would make a good or bad harvesting system.

RESOURCES:

Low-Volume Irrigation Design and Installation Guide, published by the City of Albuquerque, is an easy how-to guide for installation and maintenance of drip irrigation systems. It is available in Albuquerque through the City of Albuquerque or for the rest of the state from the New Mexico Office of the State Engineer. (See Appendix F for ordering information.)

Rainwater Harvesting, Supply from the Sky, published by the City of Albuquerque, is a detailed booklet on how to start a rainwater harvesting project. It includes information on passive systems such as berming and active systems with cisterns. However, this guide does not include information on collecting water for potable uses. It is available in Albuquerque through the City of Albuquerque or for the rest of the state from the New Mexico Office of the State Engineer. (See Appendix F for ordering information.)

http://www.twdb.state.tx.us/assistance/conservation/rain.htm – The Texas Water Development Board has a very complete rainwater harvesting pdf file that includes information about collecting water for potable uses.

http://www.cadvision.com/rolld/indexdrip.htm – This online Digital Drip Designer uses advanced calculations to determine watering needs for trees and row crops using drip irrigation emitters.

http://www.dripworksusa.com/ – Dripworks is an online catalogue of drip irrigation and micro irrigation supplies for homeowners, landscapers, greenhouse watering, and farmers.

http://jessstryker.com/ – Landscape design tutorials from a private landscape architecture firm. They provide detailed information and schematics on how to set up sprinkler and drip irrigation systems.

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Ellefson, Connie, et. al., 1992. *Xeriscape Gardening, Water Conservation for the American Landscape*. New York: MacMillan Publishing Company.

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