UNIT C

WATER CONSERVATION, WATER QUALITY PROTECTION & STORMWATER MANAGEMENT

NM Standards and Benchmarks

Social Studies

Economics Strand, Content Standard IV-B:
Analyze and evaluate how economic systems impact the way individuals, households, businesses, governments, and societies make decisions about resources and the production and distribution of goods and services
Performance Standard #8:
Evaluate economic systems by their ability to achieve broad societal goals (e.g., efficiency, equity, security, employment, stability, economic growth.)

Science

Strand III, Science and Society, Content Standard I:
Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications.
Performance Standard #4:
Understand the scientific foundations of common technologies (e.g., kitchen appliances, radio, television, aircraft, rockets, computers, medical X-rays, selective breeding, fertilizers and pesticides, agricultural equipment).

Career Readiness, Content Standard III and IV

Students will demonstrate the technological knowledge and skills required for future careers.
Students will develop and demonstrate responsible and ethical workplace behaviors.

Mathematics

Strand: Data Analysis and Probability
Students will understand how to formulate questions, analyze data, and determine probabilities.

Content

Water is essential for life and shapes every aspect of our lives. In the arid Southwest, protection of our limited water resources is vital to the future and economic vitality of our communities. In this unit, students will learn about water scarcity, the water-energy nexus, water quality problems and stormwater issues. The students will be introduced to technologies for water conservation, water treatment for water quality protection, and new techniques for stormwater management. What are the green jobs available in these areas and what are the available training and education programs for green careers in the water sector?

Vocabulary

groundwater
aquifer
water table
water conservation
run-off
surface water
watershed
water rights
water shortages
water pollution
water quality
non-point source pollution
pollution prevention
water-energy nexus
climate adaptation
vulnerability
stormwater management
green infrastructure
watershed divide
hydrology
drop-structure
restoration
reclamation
rainwater harvesting
water waste

Essential Questions

- In water conservation, water quality protection and storm water management, what careers are emerging and what interests me?
- What career paths interest me and suit my talents?
- What are the skill-sets needed to be successful in the workplace?

Focus Questions

- What is the availability of clean water in my community?
- What are the various sources of surface and ground water pollution in my community?
- What are the various technologies used to conserve and protect water resources?

Time Allocation

2 weeks

Introduction

(3 classes)

Objective:

Students will demonstrate understanding of the environmental, social, and economic implications of water conservation, water quality protection and stormwater management.

Activities:

1) Water Availability Demonstration

Humans must have freshwater to live but about 97% of the Earth's water is too salty to use. The remaining 3% is fresh water, but most of it is in polar icecaps, remote glaciers and icebergs. Accessible freshwater, therefore, comes from streams, lakes, and underground sources, which represent less than one half of 1% of all water on Earth.

Materials: (4) 1000-mL graduated cylinders; (4) smaller graduated cylinders; 1000 mL of water.

Resources:

- Water Availability Demonstration www.whittsclass.com/Word/Water%20Distribution%20on%20Earth.doc
- Graphic - Total global saltwater and freshwater estimates http://maps.grida.no/go/graphic/total_global_saltwater_and_freshwater_estimates

Assessment: Complete interpretive questions with at least 70% accuracy.

2) The Politics of Water

Discuss the politics of water, "water wars," and privatization of water resources. Share as slide or handout, "The Scale of the Water Problem" (*Global Issues*, 2010 – see Resources below). Demonstrate that water problems are not just in third world countries, but also here in the southwest. Climate change is predicted to exacerbate our already stressed water resources. Select from list of video clips below.

- *Cadillac Desert: The American West and Its Disappearing Water*, Marc Reisner (Penguin Books, 1986). Video clip (9 min): http://www.youtube.com/watch?v=hkbebOhnCjA&playnext=1&list=PL30D712F8CD920116
- Water Wars Part 1 – The Weather Channel http://www.youtube.com/watch?v=vy4WmRBUmW0&feature=related
- Water Wars Part 2 – The Weather Channel http://www.youtube.com/watch?v=nkIkIvjuv0c&feature=channel

Materials: laptop, projector, slides, handouts.

Resources:

- "Water and Development: The Scale of the Water Problem," (*Global Issues*, June 6, 2010) http://www.globalissues.org/article/601/water-and development#Thescaleofthewaterproblem
- *Water: Use Less, Save More*, Clift and Cuthbert (Chelsea Green Guides, 2007)

3) Water Quality Protection

What are the sources of pollution that impair our surface and groundwater quality (e.g., non-point source pollution runoff in storm water, industrial waste discharged directly to waterways, wastewater treatment plant outflows to waterways, stream bank erosion, etc)? What types of technologies can be used to prevent water pollution? Share handout, "The Water We Waste" (Appendix C.1) and information from resources below. Brainstorm and make a list to prepare for the up-coming class: What is being done by individuals and municipalities to conserve fresh water, prevent water pollution, treat polluted water and adapt to climate change?

Materials: laptop, projector, slides, handouts.

Resources:

- EPA Gateway to Water Issues http://www.epa.gov/gateway/learn/water.html
- *In Hot Water: Water Management Strategies to Weather the Effects of Global Warming* http://www.nrdc.org/globalWarming/hotwater/contents.asp
- Stormwater Management by Oregon Tradeswomen (PowerPoint) http://www.greenforall.org/stormwater-management/

Homework: Get a copy of the Safe Drinking Water Report for your public water supply (http://water.epa.gov/drink/local/index.cfm). Where does your drinking water come from? What is the quality of your water? Is your water safe to drink? Does your community have any water supply (i.e., water scarcity) issues?

Assessment: participation in discussions, on-task behavior, brainstormed list of what is currently being done to conserve and treat water.

Applied Science in Water Conservation

(2 classes)

Objective:

Student will demonstrate basic competency in the applied science involved in water conservation.

Activities:

1) Household Water Use and Conservation

   Use the water footprint calculator (http://www.h20conserve.org/?page_id=503) to determine your "water footprint" and learn ways to reduce water use in your home. What is your water footprint? How can you conserve water in the home as well as through lifestyle choices?

   Math exercise

   Bring in a sample water bill and calculate your water use: average gallons/month and gallons/day. Calculate the cost per gallon of water used and cost of water use per day.

   Are You a Water Saint or Water Sinner?
   Have student complete an inventory of water use activity in table (See Appendix C.3). What is your total water use per day and total per month? How can you cut down on your personal water use?

   Materials: laptop, projection, water bill, worksheet

   Resources:
   - "Are you a Water Saint or Water Sinner" and notes for use (Appendix C.2)
   - H_2O Conserve Water Conservation Calculator http://www.h20conserve.org/?page_id=503
   - EPA's WaterSense - http://www.epa.gov/watersense/

   Assessment: Complete interpretive questions with at least 70% accuracy.

2) Water-Energy Nexus and Water Conservation

   Because saving water saves energy and saving energy saves water, there is a significant potential to save both energy and water and reduce climate-changing greenhouse gas emissions by understanding and addressing the "water-energy nexus." At least 13% of the nation's energy consumption is used to pump, heat and treat water. Similarly, in 2000 thermoelectric power generation accounted for 39% of freshwater withdrawals in the U.S.

Watch the video "The Power Couple", which demonstrates the close connection between water use and electricity usage. Discuss the math based on previous day's calculations of cost of water per day. Using calculations discussed in the film, have class figure how much their daily water use costs in electricity.

How can "gray water" be reused to conserve water? Discuss the science behind gray water capture from the kitchen sink, bathroom sink, bathtub and washing machine, only when using biodegradable soaps. Why can't we use the "black water" from the toilet in the same way?

What is the science involved in building/designing a home gray water system?

Materials: laptop, projector, previous day's math calculations.

Resources:

- The Power Couple – Video on the Water-Energy Nexus by PNM and Bernalillo County Water Utility Authority http://www.youtube.com/watch?v=oGv-wLWZVf0
- Water and Energy Savings graphic from Bernalillo County Water Utility Authority (Appendix C.3)
- EnviroTV: Water Supply and Climate Change http://www.youtube.com/watch?v=XaJ4neDi_rc
- Using Gray Water in New Mexico's Residential Landscapes (http://www.ose.state.nm.us/water-info/conservation/pdf-manuals/GrayWaterBrochure.pdf)
- New Mexico Gray Water Guide (http://www.ose.state.nm.us/water-info/conservation/pdf-manuals/NewMexGWGuide.pdf)

Applied Science in Green Infrastructure

(1 – 2 classes)

Objective:

Student will demonstrate basic competency in the applied science involved in green infrastructure and restoration technologies.

Activities:

1) "Walk-Around" with a Green Infrastructure Expert

Invite a Green Infrastructure or Rainwater Harvesting Expert to visit your class. Walk students around the school grounds looking for water runoff areas such as roofs, parking lots and hillsides. Observe "watershed divides" on property. Evaluate how rainwater could be diverted to water plant stock on property or to soak into the water table, and ultimately save on tap water use. Demonstrate "reading the landscape" and allow students to practice.

2) Mathematics: Annual volume of rainwater that can be captured from the school roof

Have students calculate the possible volume of rainwater that can be captured from the school roof in one year. Measure the area of the roof. Estimate "catchment area" by multiplying length by width of the building. Next, calculate the possible annual volume of runoff from the roof by multiplying the catchment area by the annual precipitation of your area (in feet) times the volume of water per cubic foot of catchment area (7.48 gallons/cubic foot of catchment area).

catchment area (ft^2) x rainfall (ft) x 7.48 gal/ ft^3 = maximum runoff (gal)

For more information on water harvesting calculations, visit:
http://www.oasisdesign.net/water/rainharvesting/drylandsbook/Appendix3Calculations.pdf

Homework: Distribute copies of "Underground Green Economy Employing Millions", an op-ed article from *The Grist* (http://www.grist.org/article/underground-green-economy-employing-millions). Ask students to underline a quote with which they agree and one with which they disagree. Be prepared to give reasons for your agreement or disagreement in following class.

3) Dry-land Water Resources

1. Take first 10 minutes of class to discuss op-ed article read for homework (points of agreement /disagreement).

2. Present ways in which communities can reduce, reuse and recycle water and discuss slide show, "Water Harvesting" by Van Clothier of Stream Dynamics (available through author: streamdynamics@aznex.net) which demonstrates examples of water waste and demonstration projects to correct and restore our landscape). Present the concept of water harvesting and green infrastructure, including statistics on how much water can be saved per capita (or household) per day. What other conservation measures including behavior changes can households use both inside and outside?

   Discuss water reuse systems in your community. Is your wastewater treatment plant directing treated water to a baseball field or park? Although residential gray water systems are legal in New Mexico, some local municipalities may have restrictions on gray water use.

   In the last 10 minutes of class, deliver water resources vocabulary quiz. Last 10 minutes, have students use the previous day's measurement to calculate the potential harvest of rainwater from the school's roof.

   Materials: slide show, lap top, projection.

   Resources:
   - "Watershed Abuse – The Effect on a Town" Columbus (*Rangelands,* August 1980) (Appendix C.4)

- Water Harvesting PowerPoint – contact Van Clothier for copy at streamdynamics@aznex.net
- Rainwater Harvesting for Drylands http://www.harvestingrainwater.com/
- New Mexico: Water Conservation Outdoors http://www.ose.state.nm.us/wucp_home_owners_outdoors.html
- Types, Applications, and Design Approaches to Manage Wet Weather http://cfpub.epa.gov/npdes/greeninfrastructure/technology.cfm

Assessment: participation in op-ed discussion, engagement in slide show discussion, 70% on vocabulary quiz.

Homework: Home Water Audit, www.und.edu/instruct/eng/fkarner/pages/hands.htm

Laboratory Activity
(1 class)

1) Construction of an Urban Stormwater Harvesting Basin

Identify and work collaboratively with a Green Infrastructure or Rainwater Harvesting Expert to design this laboratory activity. It can be done in the community as a hands-on training and will take approximately six hours. This can be done over two late afternoons or on a Saturday. This can replace three subsequent classes.

Identify a location on school grounds or in the community where stormwater could be collected from the landscape and put to beneficial use. After gaining proper permissions from school and/or the city government as applicable, the expert will help the class implement the project.

Materials: To be determined with guest expert. You will possibly need power tools (used only by adult supervisor). Students need gloves, wheel barrow, shovels, trowels, concrete mix, and a 10-gallon container of water.

2) Alternative Activities in water conservation, water quality protection, and stormwater management

- Rainwater Harvesting Demonstration Project Videos http://www.harvestingrainwater.com/imagesvideoaudio/water-harvesting-video-and-audio/
- Visit your local water utilities department and learn how your drinking water is treated before it is distributed to your community.
- Visit your local wastewater treatment plant and learn about the various methods of wastewater treatment.

- Montrose, CO wastewater treatment plant virtual tour http://www.youtube.com/watch?v=r6ycWxw-nZI.
- Visit abandoned mine clean-up and reclamation site in your area and observe how the mine manages stormwater to reduce water infiltration to tailings, waste rock and stock piles and prevent erosion.

Employment and Training Prospects in Water Conservation, Water Quality Protection and Stormwater Management

(1 – 2 classes)

Objective:

The student will identify green jobs in these fields and identify training resources and skill sets necessary for a career in these occupations.

Activities:

1) Share the following information with the class.

Background:

- According to the NM Economic Development Department, demand for workers in wastewater management, treatment, reduction is expected to increase by 14% from 2006 – 2014 in New Mexico.
- The Bureau of Labor Statistics estimates greater than average job growth for occupations such as landscape architects, civil engineers, and environmental engineers between 2008 and 2018.
- Job opportunities should be excellent for Water and Liquid Waste Treatment Plant and System Operators, both because of the expected much faster than average employment growth and because the retirement of the baby-boomer generation will require that many operators be replaced. Further, the number of applicants for these jobs is normally low, primarily because of the physically demanding and unappealing nature of some of the work. Opportunities should be best for people with mechanical aptitude and problem-solving skills.
- Employment of environmental science and protection technicians is expected to grow much faster than average, at a rate of 29 percent according to the Bureau of Labor Statistics. These workers will be needed to help regulate waste products; collect air, water, and soil samples for measuring levels of pollutants; monitor compliance with environmental regulations; and clean up contaminated sites. Most of this growth is expected to be in firms that assist other companies in environmental monitoring, management, and regulatory compliance.
- Research indicates that the potential economic benefits of widespread green infrastructure implementation are substantial. According to a study by American Rivers, NRDC, and other groups, 153 water-related green infrastructure projects worth $1.025 billion are ready to be implemented within 6 to 9 months in communities across the country. Additionally, an

economic analysis conducted by the Alliance for Water Efficiency estimated that a direct investment of $10 billion in water efficiency programs has the potential to increase U.S. GDP by $13 to $15 billion and create 150,000 to 220,000 jobs.

Green Job Occupations in Water Conservation, Water Quality Protection, Stormwater Management (from NM Green Jobs Portal)

Environmental Science and Protection Technicians, Including Health
Water and Liquid Waste Treatment Plant and System Operators
Landscaping and Groundskeeping Workers
Civil Engineers
Environmental Engineers
Conservation Scientists
Environmental Scientists and Specialists, Including Health
Urban and Regional Planners
Landscape Architects

The Pathway Knowledge and Skills Chart for Natural Resources System Pathway
This document describes what all/most learners/workers need to know and be able to do to demonstrate competence within a career pathway.
http://www.careerclusters.org/resources/pos_ks/KSChart/2008/AG-125-KSCHART.pdf

Green Job Videos

- Job profile –Water and Liquid Waste Treatment Plant and System Operators
  http://www.youtube.com/watch?v=7PfyWi5l3Vo&feature=related
- Green Careers: Water Management – Civil Engineer
  http://www.youtube.com/watch?v=kqjMGTmmvWw&feature=channel

Resources:

- NM Green Job Portal
  www.greenjobs.state.nm.us
- Green Jobs Outlook - NM Green Jobs Guidebook
  http://newenergyeconomy.org/wp-content/uploads/2011/03/nmGreenJobsGuidebook.pdf
- NM Green Job Career Pathways
  http://www.greenjobs.state.nm.us/pdf/GreenPathways.pdf
- NM Green Jobs Educational Opportunities
  http://www.greenjobs.state.nm.us/education.html
- NM Green Certifications
  http://www.greenjobs.state.nm.us/pdf/GreenCertificates.pdf
- EPA Green Infrastructure Jobs Training Catalog
  http://www.epa.gov/npdes/pubs/greenjobscatalog2010.pdf
- **Santa Fe Community College Sustainable Technologies Center**
  - Introduction to Water Conservation Technologies - origin, history, and technology of water and wastewater.

    - Water Conservation Technologies - sustainable design concepts and principles, water conservation practices, environmental elements, construction and project management, and real world skills.
- **Watershed Management Group** – Tucson, AZ www.watershedmg.org
    - Water Harvesting Certification is the only such program in the nation.
    - The 67 hour curriculum includes training in integrated design and installation of water harvesting systems including water harvesting earthworks, cisterns/tanks, and gray water systems. Also covered are principles and practices of sustainable landscaping, water harvesting for food production, and developments in governmental water harvesting policy.

Formal Weekly Assessment

Objective:

Student will demonstrate with a 70% proficiency or better, his/her understanding of concepts and employment opportunities in this career cluster.

Assessment: weekly assessment based on Weekly Grading Rubric (See Appendix I.8)