High School Lesson Plan #3

COURSE(S): Algebra I; Mathematical Modeling with Applications; Environmental Studies; Aquatic Sciences; Geology, Meteorology, and Oceanography; US History Since Reconstruction; World Geography Studies

TOPIC: Water Availability, Usage and Future Demand in Texas

TITLE: Water: On the Surface and in the Ground

OVERVIEW: The student will understand that water resources include both surface water and ground water. The student will study a Texas river basin and a major Texas aquifer. The student will map information and write a short report.

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS:

Algebra I
(b) Foundations for functions: knowledge and skill and performance descriptions.
   (1) The student understands that a function represents a dependence of one quantity on another and can be described in a variety of ways. Following are performance descriptions.
      (B) The student gathers and records data, or uses data sets, to determine functional (systematic) relationships between quantities.
      (D) The student represents relationships among quantities using concrete models, tables, graphs, diagrams, verbal descriptions, equations, and inequalities.
      (E) The student interprets and makes inferences from functional relationships.
   (c) Linear functions: knowledge and skills and performance descriptions.
      (1) The student understands that linear functions can be represented in different ways and translates among their various representatives. Following are performance descriptions.
         (A) The student determines whether or not given situations can be represented by linear functions.
         (C) The student translated among and uses algebraic, tabular, graphical, or verbal descriptions of linear functions.
      (2) The student understands the meaning of slope and intercepts of linear functions and interprets and describes the effects of changes in parameters of linear functions in real-world and mathematical situations. Following are performance descriptions.
         (A) The student develops the concept of slope as rate of change and determines slopes from graphs, tables, and algebraic representations.
         (B) The student interprets the meaning of slope and intercepts in situations using data, symbolic representations, and graphs.

Mathematical Models with Applications
(c) Knowledge and Skills
(1) The student uses a variety of strategies and approaches to solve both routine and non-routine problems. The student is expected to:
   (A) compare and analyze various methods for solving a real-life problem.
   (B) use multiple approaches (algebraic, graphical, and geometric methods) to solve problems from a variety of disciplines.

(2) The student uses graphical and numerical techniques to study patterns and analyze data. The student is expected to:
   (A) interpret information from various graphs, including line graphs, bar graphs, circle graphs, histograms, and scatter plots to draw conclusions from the data.
   (B) analyze numerical data using measures of central tendency, variability, and correlation in order to make inferences.

Environmental Studies
(c) Knowledge and Skills

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:
   (B) identify source, use, quality, and conservation of water.

(7) Science concepts. The student knows the relationship between carrying capacity and changes in populations and ecosystems. The student is expected to:
   (A) relate carrying capacity to population dynamics.
   (D) analyze and make predictions about the impact on populations of geographic locales, natural events, diseases, and birth and death rates.

(8) Science concepts. The student knows that environments change. The student is expected to:
   (A) analyze and describe the effects on environments of events such as fires, hurricanes, deforestation, mining, population growth, and municipal development.

Aquatic Sciences
(c) Knowledge and Skills

(8) Science concepts. The student knows that aquatic environments change. The student is expected to:
   (B) analyze the cumulative impact of natural and human influence on an aquatic system.
   (C) identify and describe a local or global issue affecting an aquatic system.
   (D) analyze and discuss human influences on an aquatic environment including fishing, transportation, and recreation.

(10) Science concepts. The students knows the origin and use of water in a watershed. The student is expected to:
   (A) identify sources and determine the amounts of water in a watershed including groundwater and surface water.
   (B) research and identify the types of uses and volumes of water used in a water shed.
   (C) identify water quantity and quality in a local watershed.
**Geology, Meteorology, and Oceanography**

(c) Knowledge and Skills

(10) Science concepts. The student knows the interactions that occur in a watershed. The student is expected to:

(A) identify the characteristics of a local watershed such as average annual rainfall, run-off patterns, aquifers, locations of river basins, and surface water reservoirs.

(C) describe the importance and sources of surface and subsurface water.

**United States History Studies Since Reconstruction**

(c) Knowledge and Skills

(8) Geography. The student uses geographical tools to collect, analyze and interpret data. The student is expected to:

(B) pose and answer questions about geographic distributions and patterns shown on maps, graphs, charts, models, and databases.

(11) Geography. The student understands the relationship between population growth and modernization on the physical environment. The student is expected to:

(A) identify the effects of population growth and distribution and predict future effects on the physical environment.

(24) Social studies skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:

(B) analyze information by sequencing, categorizing, identifying cause-and-effect relationships, comparing, contrasting, finding the main idea, summarizing, making generalizations and predictions, and drawing inferences and conclusions.

(H) use appropriate mathematical skills to interpret social studies information such as maps and graphs.

(25) Social studies skills. The student communicates in written, oral, and visual forms. The student is expected to:

(A) use social studies terminology correctly.

(B) use standard grammar, spelling, sentence structure, and punctuation.

(C) transfer information from one medium to another, including written to visual and statistical to written or visual, using computer software as appropriate.

(D) create written, oral, and visual presentations of social studies information.
World Geography Studies
(c) Knowledge and Skills

(8) Geography. The student understands how people, places, and environments are connected and interdependent. The student is expected to:
(A) explain the interrelationships among physical and human processes that shape the geographic characteristics of places such as connections among economic development, urbanization, population growth, and environmental change.
(B) compare ways that humans depend on, adapt to, and modify the physical environment using local, state, national, and international human activities in a variety of cultural and technological contexts.

(21) Social studies skills. The student applies critical-thinking skills to organize and use information acquired from a variety of sources including electronic technology. The student is expected to:
(B) analyze and evaluate the validity and utility of multiple sources of geographic information such as primary and secondary sources, aerial photographs, and maps.
(C) construct and interpret maps to answer geographic questions, infer geographic relationships, and analyze geographic change.

(22) Social studies skills. The student communicates in written, oral, and visual forms. The student is expected to:
(A) design and draw appropriate maps and other graphics such as sketch maps, diagrams, tables, and graphs to present geographic information including geographic features, geographic distributions, and geographic relationships.
(B) apply appropriate vocabulary, geographic models, generalizations, theories, and skills to present geographic information.

RELATED ESSENTIAL KNOWLEDGE AND SKILL:

Environmental Studies
(c) Knowledge and Skills

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:
(F) evaluate the impact of human activity and technology on land fertility and aquatic viability.

(7) Science concepts. The student knows the relationship between carrying capacity and changes in populations and ecosystems. The student is expected to:
(D) analyze and make predictions about the impact on populations of geographic locales, natural events, diseases, and birth and death rates.
United States History Studies Since Reconstruction
(c) Knowledge and Skills
(26) Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. The student is expected to:
(A) use a problem-solving process to identify a problem, gather information, list and consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.
(B) use a decision-making process to identify a situation that requires a decision, gather information, identify options, predict consequences, and take action to implement a decision

English I
(b) Knowledge and Skills
(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:
(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.
(D) produce error-free writing in the final draft.
(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:
(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.
(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English II
(b) Knowledge and Skills
(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:
(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.
(D) produce error-free writing in the final draft.
(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:
(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.
(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English III
(b) Knowledge and Skills
(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:
    (A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.
    (D) produce error-free writing in the final draft.
(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:
    (D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.
    (F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

**English IV**

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:
    (A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.
    (D) produce error-free writing in the final draft.
(4) Writing/inquiry/research. The student uses writing as a tool for learning and research. The student is expected to:
    (E) organize notes from multiple sources in useful and informing ways such as graphics, conceptual maps, and learning logs.
    (G) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

**DID YOU KNOW?**

Here are some interesting water facts about Texas.

1. Not counting the Great Lakes, Texas ranks first in the nation for number of square miles of fresh, inland surface water (4,950 sq. mi.).
2. Caddo Lake is the only natural lake in Texas.
3. Texas has over 6,700 lakes with at least 10 surface acres. There are only 205 major reservoirs in Texas and 74 of these contain over 98% of the state’s storage capacity.
4. Texas has already developed 75-80% of its conventional (fresh ground and surface) water resources.
5. Texas has 15 major rivers.
6. There are approximately 80,000 miles of rivers and streams in Texas.
7. Major and minor aquifers underlie approximately 81% of Texas.
Definitions that are helpful when studying river basins and aquifers include:

- **river basin** - watershed or drainage area for a river and all tributaries
- **in-basin uses** - demand for water within a given river basin
- **aquifer** - area with large amounts of water located under the surface (groundwater)
- **groundwater** - water located below the surface of the land
- **recharge** - the addition of water to an aquifer

**LEARNING EXPERIENCE:**

**GENERAL TIME FRAME:** 3-5 hours depending on student responses.

**Description:** Students will research and describe a river basin located in their local Water Planning Region and an associated aquifer. The description will take the form of a written report that will include graphs showing in-basin water usage and maps showing the river basin and aquifer in relation to the rest of Texas.

**Time Frame:** 4 to 7 – 45 minute periods

**Advanced Preparation:**

1. If Internet access is available to students at the school, arrange for students to spend a minimum of one period doing research on the selected river basin and aquifer.
2. Contact the Texas Water Development Board and the Texas Natural Resource Conservation Commission for information on river basins and aquifers. (see Resources)

**Procedure:**

1. Select a river basin.
2. Indicate by color or other means the selected river basin on a map of river basins in Texas.
3. List the existing reservoirs/lakes in the river basin.
4. List planned and recommended reservoir projects in the river basin.
5. Make a map of the river basin showing the existing and all planned/recommended reservoirs.
6. Determine the major aquifer(s) in the river basin.
7. Determine the hydrogeology of the aquifer.
8. Determine the total groundwater storage capacity in the aquifer.
9. Using a bar graph, show in-basin water demands by demand segment for the years 2000 and 2050.
10. Compare in-basin water demands versus in-basin water supplies for the years 2000 and 2050 using line graphs.
11. Using the river basin and aquifer data as a basis, write a short report
discussing water availability needed to meet future demand. The report is to incorporate research findings and the constructed maps and graphs.

Teacher Talk:

The demand on water resources, both surface water and groundwater, in Texas will continue to increase for the foreseeable future. For river basins the primary question is whether or not in-basin water supplies will meet the in-basin water demands or if water will need to be imported from another part of Texas that has a surplus. For aquifers the primary question is whether or not recharge rates can meet or exceed the rate at which water is and will be removed. Excess removal of water can lead to subsidence among other problems.

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<tr>
<th>Teacher Questions</th>
<th>Possible Replies</th>
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<td>1. What is expected to cause a total water use increase or decline by the year 2050 in the selected river basin.</td>
<td>1. Student answers will vary depending on the selected river basin. For example, in many Texas river basins, the amount of water used in agriculture is expected to decline by 2050.</td>
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<td>2. What future water supplies are planned for development in the river basin?</td>
<td>2. Student answers will vary depending on the selected river basin.</td>
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<td>3. What are the dangers of overusing the available water in an aquifer?</td>
<td>3. Overuse of groundwater in an aquifer can lead to subsidence of the surface causing structural damage to roads, buildings, etc. Unless the withdrawal of water from an aquifer is balanced with water entering the aquifer from the recharge zone, eventually water from the aquifer will no longer be available until the recharge balance has been restored.</td>
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<td>4. What are ways that an aquifer can be maintained as a water resource?</td>
<td>4. Student answers will vary. Examples of possible answers are (a) limit the amount of water withdrawn from the aquifer to the recharge amount and (b) maintain the watershed(s) in the recharge zones.</td>
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RESOURCES:

Literature on water conservation by the Texas Water Development Board. View and order currently available brochures at [http://www.twdb.state.tx.us/assistance/conservation/pubs.htm](http://www.twdb.state.tx.us/assistance/conservation/pubs.htm), contact Patsy Waters at [patsy.waters@twdb.state.tx.us](mailto:patsy.waters@twdb.state.tx.us), fax the form to (512) 936-0812, call (512) 463-7955 or write to:

Conservation  
Texas Water Development Board  
P.O. Box 13231  
Austin, Texas 78711-3231

Maps of Texas River Basins, Aquifers, and Regional Reservoir Basin Maps are available on TWDB’s website at [http://www.twdb.state.tx.us/mapping/index.htm](http://www.twdb.state.tx.us/mapping/index.htm)

Use TWDB’s website to obtain information on water availability, historical/ projected water usage, and water demand data for the period from the 1990’s to 2050 ([http://www.twdb.state.tx.us/data/data.htm](http://www.twdb.state.tx.us/data/data.htm)).

EXTENSIONS:

1. Instead of having each student work independently, divide students into groups with 3-4 members each. Assign each group a different river basin to research. Have each group give an oral presentation of their findings.

2. Invite a representative of the US Army Corps of Engineers to speak to the students about the federal program to build and maintain reservoirs.