



**THE MEADOWS CENTER**  
**FOR WATER AND THE ENVIRONMENT**  

---

**TEXAS STREAM TEAM**

**Curriculum Companion:**

**Water Quality Monitoring Manual**  
**Grades 8<sup>th</sup> - 12<sup>th</sup>**

---



The preparation of this publication is financed through grants from the U.S. Environmental Protection Agency through the Texas Commission on Environmental Quality. EPA has not formally reviewed the information in this publication. The views expressed are solely those of the grant recipient.



# Introduction to Water Monitoring

## *Water Quality Sampling*

### About Texas Stream Team and this Curriculum

Since Texas Stream Team's start in 1991, "students" of the environment have come to Texas Stream Team in search of answers.

Texas Stream Team encourages everyone to ask:

- What questions do we want to answer about the environment?
- What part of the environment are we most concerned with?
- What can I do to help preserve and protect the environment?

Science teachers have come to Texas Stream Team in search of real-world activities to enhance their presentation of scientific concepts and information.

The water quality monitoring curriculum presented here is designed for High School and Middle School science teachers. This curriculum is a companion to the Texas Stream Team's Water Quality Monitoring Manual, and focuses on the key environmental and scientific concepts associated with Texas Stream Team's core water quality variables. The variables are broken down into Lessons that present multiple activities.

In addition to presenting the procedures for performing the water quality tests, this curriculum provides lessons, exercises, evaluation materials and Texas Essential Knowledge and Skills (TEKS) correlations. The Texas Stream Team hopes this curriculum will facilitate the presentation of our concepts in the classroom and field.

### Lessons

Grades 8<sup>th</sup>- 12<sup>th</sup>

#### **Introductory Lesson: The Quality of Water**

One, 45 minute session

#### **Lesson 1: Dissolved Oxygen**

Three, 45-50 minute sessions

#### **Lesson 2: Water Clarity**

Two, 45-50 minute sessions

#### **Lesson 3: Temperature**

Two, 45-50 minute sessions

#### **Lesson 4: Water pH**

Two, 45-50 minute sessions

#### **Lesson 5: Water Conductivity and Total Dissolved Solids**

Two, 45-50 minute sessions

#### **Lesson 6: Designing a Monitoring Plan - Mapping & Analysis**

Two, 45-50 minute sessions



#### **Safety Reminder**

*When you see this water  
drop, this is a reminder  
to pay attention to safety  
instructions.*

# Correlation to Texas Essential Knowledge and Skills (TEKS)

## §112.20. Science, Grade 8, Beginning with School Year 2010-2011.

(8.1) Scientific processes. The student conducts field and laboratory investigations using safe, (A) Scientific investigation and reasoning.

(i) To develop a rich knowledge of science and the natural world, students must become familiar with different modes of scientific inquiry, rules of evidence, ways of formulating questions, ways of proposing explanations, and the diverse ways scientists study the natural world and propose explanations based on evidence derived from their work.

(ii) Scientific investigations are conducted for different reasons. All investigations require a research question, careful observations, data gathering, and analysis of the data to identify the patterns that will explain the findings. Descriptive investigations are used to explore new phenomena such as conducting surveys of organisms or measuring the abiotic components in a given habitat. Descriptive statistics include frequency, range, mean, median, and mode. A hypothesis is not required in a descriptive investigation. On the other hand, when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation. Students should experience both types of investigations and understand that different scientific research questions require different research designs.

(iii) Scientific investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and the methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. Models have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(E) Organisms and environments. In studies of living systems, students explore the interdependence between these systems. Interactions between organisms in ecosystems, including producer/consumer, predator/prey, and parasite/host relationships, are investigated in aquatic and terrestrial systems. Students describe how biotic and abiotic factors affect the number of organisms and populations present in an ecosystem. In addition, students explore how organisms and their populations respond to short- and long-term environmental changes, including those caused by human activities.

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations as outlined in the Texas Safety Standards; and

(B) practice appropriate use and conservation of resources, including disposal, reuse, or recycling of materials.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:

- (A) plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology;
- (B) design and implement comparative and experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology;
- (C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
- (D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
- (E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
- (B) use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature;
- (C) identify advantages and limitations of models such as size, scale, properties, and materials; and
- (D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:

- (A) use appropriate tools to collect, record, and analyze information, including lab journals/notebooks, beakers, meter sticks, graduated cylinders, anemometers, psychrometers, hot plates, test tubes, spring scales, balances, microscopes, thermometers, calculators, computers, spectrosopes, timing devices, and other equipment as needed to teach the curriculum; and
- (B) use preventative safety equipment, including chemical splash goggles, aprons, and gloves, and be prepared to use emergency safety equipment, including an eye/face wash, a fire blanket, and a fire extinguisher.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(11) Organisms and environments. The student knows that interdependence occurs among living systems and the environment and that human activities can affect these systems. The student is expected to:

- (A) describe producer/consumer, predator/prey, and parasite/host relationships as they occur in food webs within marine, freshwater, and terrestrial ecosystems;
- (B) investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperatures, or soil composition;
- (C) explore how short- and long-term environmental changes affect organisms and traits in subsequent populations; and
- (D) recognize human dependence on ocean systems and explain how human activities such as runoff, artificial reefs, or use of resources have modified these systems.

*Source: The provisions of this §112.20 adopted to be effective August 4, 2009, 34 TexReg 5063.*

## **§112.32. Aquatic Science, Beginning with School Year 2010-2011 High School (One Credit).**

- (a) General requirements. Students shall be awarded one credit for successful completion of this course. Required prerequisite: one unit of high school Biology. Suggested prerequisite: Chemistry or concurrent enrollment in Chemistry. This course is recommended for students in Grades 10, 11, or 12.
- (b) Introduction.

- (1) Aquatic Science. In Aquatic Science, students study the interactions of biotic and abiotic components in aquatic environments, including impacts on aquatic systems. Investigations and field work in this course may emphasize fresh water or marine aspects of aquatic science depending primarily upon the natural resources available for study near the school. Students who successfully complete Aquatic Science will acquire knowledge about a variety of aquatic systems, conduct investigations and observations of aquatic environments, work collaboratively with peers, and develop critical-thinking and problem-solving skills.
- (2) Nature of science. Science, as defined by the National Academy of Sciences, is the “use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.” This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.
- (3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.
- (4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(5) Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

- (A) demonstrate safe practices during laboratory and field investigations, including chemical, electrical, and fire safety, and safe handling of live and preserved organisms; and
- (B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific methods during laboratory and field investigations. The student is expected to:

- (A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;
- (B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;
- (C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;
- (D) distinguish between scientific hypotheses and scientific theories;
- (E) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting, handling, and maintaining appropriate equipment and technology;
- (F) collect data individually or collaboratively, make measurements with precision and accuracy, record values using appropriate units, and calculate statistically relevant quantities to describe data, including mean, median, and range;
- (G) demonstrate the use of course apparatuses, equipment, techniques, and procedures;
- (H) organize, analyze, evaluate, build models, make inferences, and predict trends from data;
- (I) perform calculations using dimensional analysis, significant digits, and scientific notation; and
- (J) communicate valid conclusions using essential vocabulary and multiple modes of expression such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.



# Correlation to Texas Essential Knowledge and Skills (TEKS)

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
- (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;
- (C) draw inferences based on data related to promotional materials for products and services;
- (D) evaluate the impact of research and technology on scientific thought, society, and the environment;
- (E) describe the connection between aquatic science and future careers; and
- (F) research and describe the history of aquatic science and contributions of scientists.

(4) Science concepts. Students know that aquatic environments are the product of Earth systems interactions. The student is expected to:

- (A) identify key features and characteristics of atmospheric, geological, hydrological, and biological systems as they relate to aquatic environments;
- (B) apply systems thinking to the examination of aquatic environments, including positive and negative feedback cycles; and
- (C) collect and evaluate global environmental data using technology such as maps, visualizations, satellite data, Global Positioning System (GPS), Geographic Information System (GIS), weather balloons, buoys, etc.

(5) Science concepts. The student conducts long-term studies on local aquatic environments. Local natural environments are to be preferred over artificial or virtual environments. The student is expected to:

- (A) evaluate data over a period of time from an established aquatic environment documenting seasonal changes and the behavior of organisms;
- (B) collect baseline quantitative data, including pH, salinity, temperature, mineral content, nitrogen compounds, and turbidity from an aquatic environment;
- (C) analyze interrelationships among producers, consumers, and decomposers in a local aquatic ecosystem; and
- (D) identify the interdependence of organisms in an aquatic environment such as in a pond, river, lake, ocean, or aquifer and the biosphere.

(6) Science concepts. The student knows the role of cycles in an aquatic environment. The student is expected to:

- (A) identify the role of carbon, nitrogen, water, and nutrient cycles in an aquatic environment, including upwellings and turnovers; and
- (B) examine the interrelationships between aquatic systems and climate and weather, including El Niño and La Niña, currents, and hurricanes.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(7) Science concepts. The student 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 rainfall, groundwater, and surface water;
- (B) identify factors that contribute to how water flows through a watershed; and
- (C) identify water quantity and quality in a local watershed.

(9) Science concepts. The student knows the types and components of aquatic ecosystems. The student is expected to:

- (A) differentiate among freshwater, brackish, and saltwater ecosystems;
- (B) identify the major properties and components of different marine and freshwater life zones; and
- (C) identify biological, chemical, geological, and physical components of an aquatic life zone as they relate to the organisms in it.

(10) Science concepts. The student knows environmental adaptations of aquatic organisms. The student is expected to:

- (A) classify different aquatic organisms using tools such as dichotomous keys;
- (B) compare and describe how adaptations allow an organism to exist within an aquatic environment; and
- (C) compare differences in adaptations of aquatic organisms to fresh water and marine environments.

(11) Science concepts. The student knows about the interdependence and interactions that occur in aquatic environments. The student is expected to:

- (A) identify how energy flows and matter cycles through both fresh water and salt water aquatic systems, including food webs, chains, and pyramids; and
- (B) evaluate the factors affecting aquatic population cycles.

(12) Science concepts. The student understands how human activities impact aquatic environments. The student is expected to:

- (A) predict effects of chemical, organic, physical, and thermal changes from humans on the living and nonliving components of an aquatic ecosystem;
- (B) analyze the cumulative impact of human population growth on an aquatic system;
- (C) investigate the role of humans in unbalanced systems such as invasive species, fish farming, cultural eutrophication, or red tides;
- (D) analyze and discuss how human activities such as fishing, transportation, dams, and recreation influence aquatic environments; and
- (E) understand the impact of various laws and policies such as The Endangered Species Act, right of capture laws, or Clean Water Act on aquatic systems.

*Source: The provisions of this §112.32 adopted to be effective August 4, 2009, 34 TexReg 5063*



# Correlation to Texas Essential Knowledge and Skills (TEKS)

## **§112.34. Biology, Beginning with School Year 2010-2011 High School (One Credit).**

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grade 9, 10, or 11.

(b) Introduction.

(1) Biology. In Biology, students conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the “use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.” This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).

(5) Science, systems, and models. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations; and

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

(B) know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(C) know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;

(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, gel electrophoresis apparatuses, micropipettors, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, cameras, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;

(G) analyze, evaluate, make inferences, and predict trends from data; and

(H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

(C) draw inferences based on data related to promotional materials for products and services;

(D) evaluate the impact of scientific research on society and the environment;

(E) evaluate models according to their limitations in representing biological objects or events; and

(F) research and describe the history of biology and contributions of scientists.

(11) Science concepts. The student knows that biological systems work to achieve and maintain balance. The student is expected to:

(A) describe the role of internal feedback mechanisms in the maintenance of homeostasis;

(B) investigate and analyze how organisms, populations, and communities respond to external factors;

(C) summarize the role of microorganisms in both maintaining and disrupting the health of both organisms and ecosystems; and

(D) describe how events and processes that occur during ecological succession can change populations and species diversity.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(12) Science concepts. The student knows that interdependence and interactions occur within an environmental system. The student is expected to:

- (A) not applicable;
- (B) compare variations and adaptations of organisms in different ecosystems;
- (C) analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids;
- (D) recognize that long-term survival of species is dependent on changing resource bases that are limited;
- (E) describe the flow of matter through the carbon and nitrogen cycles and explain the consequences of disrupting these cycles; and
- (F) describe how environmental change can impact ecosystem stability.

*Source: The provisions of this §112.34 adopted to be effective August 4, 2009, 34 TexReg 5063.*

## **§112.35. Chemistry, Beginning with School Year 2010-2011 High School (One Credit).**

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Required prerequisites: one unit of high school science and Algebra I. Suggested prerequisite: completion of or concurrent enrollment in a second year of math. This course is recommended for students in Grade 10, 11, or 12.

(b) Introduction.

(1) Chemistry. In Chemistry, students conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include characteristics of matter, use of the Periodic Table, development of atomic theory and chemical bonding, chemical stoichiometry, gas laws, solution chemistry, thermochemistry, and nuclear chemistry. Students will investigate how chemistry is an integral part of our daily lives.

(2) Nature of Science. Science, as defined by the National Academy of Sciences, is the “use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.” This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.

(5) Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students

# Correlation to Texas Essential Knowledge and Skills (TEKS)

should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

- (A) demonstrate safe practices during laboratory and field investigations, including the appropriate use of safety showers, eyewash fountains, safety goggles, and fire extinguishers;
- (B) know specific hazards of chemical substances such as flammability, corrosiveness, and radioactivity as summarized on the Material Safety Data Sheets (MSDS); and
- (C) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific methods to solve investigative questions. The student is expected to:

- (A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;
- (B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;
- (C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but may be subject to change as new areas of science and new technologies are developed;
- (D) distinguish between scientific hypotheses and scientific theories;
- (E) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including graphing calculators, computers and probes, sufficient scientific glassware such as beakers, Erlenmeyer flasks, pipettes, graduated cylinders, volumetric flasks, safety goggles, and burettes, electronic balances, and an adequate supply of consumable chemicals;
- (F) collect data and make measurements with accuracy and precision;
- (G) express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures;
- (H) organize, analyze, evaluate, make inferences, and predict trends from data; and
- (I) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

- (3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:
- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
  - (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;
  - (C) draw inferences based on data related to promotional materials for products and services;
  - (D) evaluate the impact of research on scientific thought, society, and the environment;
  - (E) describe the connection between chemistry and future careers; and
  - (F) research and describe the history of chemistry and contributions of scientists.

*Source: The provisions of this §112.35 adopted to be effective August 4, 2009, 34 TexReg 5063*

## **§112.37. Environmental Systems, Beginning with School Year 2010-2011 High School (One Credit).**

- (a) General requirements. Students shall be awarded one credit for successful completion of this course. Suggested prerequisite: one unit high school life science and one unit of high school physical science. This course is recommended for students in Grade 11 or 12.
- (b) Introduction.
- (1) Environmental Systems. In Environmental Systems, students conduct laboratory and field investigations, use scientific methods during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include: biotic and abiotic factors in habitats, ecosystems and biomes, interrelationships among resources and an environmental system, sources and flow of energy through an environmental system, relationship between carrying capacity and changes in populations and ecosystems, and changes in environments.
  - (2) Nature of science. Science, as defined by the National Academy of Sciences, is the “use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.” This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.
  - (3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.
  - (4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(5) Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts hands-on laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations, including appropriate first aid responses to accidents that could occur in the field such as insect stings, animal bites, overheating, sprains, and breaks; and

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific methods during laboratory and field investigations. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

(B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;

(C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) follow or plan and implement investigative procedures, including making observations, asking questions, formulating testable hypotheses, and selecting equipment and technology;

(F) collect data individually or collaboratively, make measurements with precision and accuracy, record values using appropriate units, and calculate statistically relevant quantities to describe data, including mean, median, and range;

(G) demonstrate the use of course apparatuses, equipment, techniques, and procedures, including meter sticks, rulers, pipettes, graduated cylinders, triple beam balances, timing devices, pH meters or probes, thermometers, calculators, computers, Internet access, turbidity testing devices, hand magnifiers, work and disposable gloves, compasses, first aid kits, binoculars, field guides, water quality test kits or probes, soil test kits or probes, 100-foot appraiser's tapes, tarps, shovels, trowels, screens, buckets, and rock and mineral samples;



# Correlation to Texas Essential Knowledge and Skills (TEKS)

- (H) use a wide variety of additional course apparatuses, equipment, techniques, materials, and procedures as appropriate such as air quality testing devices, cameras, flow meters, Global Positioning System (GPS) units, Geographic Information System (GIS) software, computer models, densimeters, clinometers, and field journals;
- (I) organize, analyze, evaluate, build models, make inferences, and predict trends from data;
- (J) perform calculations using dimensional analysis, significant digits, and scientific notation; and
- (K) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
- (B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;
- (C) draw inferences based on data related to promotional materials for products and services;
- (D) evaluate the impact of research on scientific thought, society, and the environment;
- (E) describe the connection between environmental science and future careers; and
- (F) research and describe the history of environmental science and contributions of scientists.

(4) Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to:

- (A) identify native plants and animals using a dichotomous key;
- (B) assess the role of native plants and animals within a local ecosystem and compare them to plants and animals in ecosystems within four other biomes;
- (C) diagram abiotic cycles, including the rock, hydrologic, carbon, and nitrogen cycles;
- (D) make observations and compile data about fluctuations in abiotic cycles and evaluate the effects of abiotic factors on local ecosystems and local biomes;
- (E) measure the concentration of solute, solvent, and solubility of dissolved substances such as dissolved oxygen, chlorides, and nitrates and describe their impact on an ecosystem;
- (F) predict how the introduction or removal of an invasive species may alter the food chain and affect existing populations in an ecosystem;
- (G) predict how species extinction may alter the food chain and affect existing populations in an ecosystem; and

# Correlation to Texas Essential Knowledge and Skills (TEKS)

(H) research and explain the causes of species diversity and predict changes that may occur in an ecosystem if species and genetic diversity is increased or reduced.

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:

- (A) summarize methods of land use and management and describe its effects on land fertility;
- (B) identify source, use, quality, management, and conservation of water;
- (C) document the use and conservation of both renewable and non-renewable resources as they pertain to sustainability;
- (D) identify renewable and non-renewable resources that must come from outside an ecosystem such as food, water, lumber, and energy;
- (E) analyze and evaluate the economic significance and interdependence of resources within the environmental system; and
- (F) evaluate the impact of waste management methods such as reduction, reuse, recycling, and composting on resource availability

(9) Science concepts. The student knows the impact of human activities on the environment. The student is expected to:

- (A) identify causes of air, soil, and water pollution, including point and nonpoint sources;
- (B) investigate the types of air, soil, and water pollution such as chlorofluorocarbons, carbon dioxide, pH, pesticide runoff, thermal variations, metallic ions, heavy metals, and nuclear waste;
- (C) examine the concentrations of air, soil, and water pollutants using appropriate units;
- (D) describe the effect of pollution on global warming, glacial and ice cap melting, greenhouse effect, ozone layer, and aquatic viability;
- (E) evaluate the effect of human activities, including habitat restoration projects, species preservation efforts, nature conservancy groups, hunting, fishing, ecotourism, all terrain vehicles, and small personal watercraft, on the environment;
- (F) evaluate cost-benefit trade-offs of commercial activities such as municipal development, farming, deforestation, over-harvesting, and mining;
- (G) analyze how ethical beliefs can be used to influence scientific practices such as methods for increasing food production;
- (H) analyze and evaluate different views on the existence of global warming;
- (I) discuss the impact of research and technology on social ethics and legal practices in situations such as the design of new buildings, recycling, or emission standards;
- (J) research the advantages and disadvantages of “going green” such as organic gardening and farming, natural methods of pest control, hydroponics, xeriscaping, energy-efficient homes and appliances, and hybrid cars;
- (K) analyze past and present local, state, and national legislation, including Texas automobile emissions regulations, the National Park Service Act, the Clean Air Act, the Clean Water Act, the Soil and Water Resources Conservation Act, and the Endangered Species Act; and
- (L) analyze past and present international treaties and protocols such as the environmental Antarctic Treaty System, Montreal Protocol, and Kyoto Protocol.

*Source: The provisions of this §112.37 adopted to be effective August 4, 2009, 34 TexReg 5063.*

# Introductory Lesson

## *The Quality of water*

### Process/Activity:

1. Gather materials
2. Prepare the cups of water.
  - a. Cup 1: tap water
  - b. Cup 2: bottled water
  - c. Cup 3: bottled water with 3 drops food coloring
  - d. Cup 4: bottled water with 1/2 cup leaf litter
  - e. Cup 5: tap water with 1 tablespoon rubbing alcohol
  - f. Cup 6: carbonated water.
3. Ask students to evaluate the water quality of each cup **WITHOUT DRINKING THE WATER**. Remind the students that early chemists tended to die young because they would taste unknown compounds. Students do not know what is in the water, so must only use their powers of observation and smell.
4. Have the groups evaluate the cups of water.
5. Optional: Each group will present a list of cups with good water quality to the class.
6. Tell the students what each cup contains, and how it might impact water quality for human consumption and as habitat for aquatic organisms.

### Cup Contents - How they affect water quality:

- Cup 1: tap water has chlorine Chlorine makes water safe for drinking, but burns the gills of aquatic animals, and eliminates the bacteria and protists that are the base of the aquatic food chain.
- Cup 2: bottled water This water lacks chlorine, and is safe as habitat and for drinking.
- Cup 3: colored bottled water The coloring does not affect its safety for drinking, however, it will affect the water as habitat. When water becomes less clear, the ability of plants to photosynthesize or predators to find prey is negatively impacted.
- Cup 4: bottled water with leaf litter The introduced impurities make the water unsafe to drink
- but the leaf litter, in small quantities, does not negatively impact water for habitat.
- Cup 5: tap water with rubbing alcohol The water appears clear and clean, but is actually toxic to humans and as habitat for aquatic organisms.
- Cup 6: carbonated water Soda water is fine for drinking, but the additional gases change the pH values, making it unfit as habitat for some species.

### Academic Question:

What are the water qualities that determine if water is good for human consumption and as habitat for aquatic organisms?

### Objectives:

- To understand variables that effect water quality.
- To differentiate water qualities that affect human safety and homes/habitat for aquatic organisms.

### Materials:

- 6 numbered cups per group - 8 oz, clear,
- food coloring, one bottle per group,
- 1 16-oz bottle rubbing alcohol, add 1 tbsp per group
- bucket of leaf litter
- bottled water, enough to fill three 6-8 oz cups per group
- club soda, enough to fill one 6-8 oz cup per group
- measuring Tablespoons, measuring cup - 1/2 cup
- tap water, enough to fill two 6-8 oz cups per group