CHEMISTRY

Water Quality Testing Project
Lessons 1-4

By Gary Martindale
Pajaro Valley High School

WETLANDS WATER QUALITY TESTING PROJECT (WQTP) INTRODUCTION

Pajaro Valley High School is located in a unique region of California's Central Coast. Adjacent to the school campus is a network of freshwater sloughs, which ultimately drain to Monterey Bay. These freshwater bodies afford a unique opportunity for high school students to monitor water quality within this slough network. One of these sloughs, West Struve Slough, is in close proximity to the school campus, and its waters are easily accessible to the high school teachers and their students. Utilizing this water resource to engage students in 'hands-on" investigation of water quality, is a primary intent of this "Wetlands Water Quality Testing Project"(WQTP).

This is a quarter long project in which students will be introduced to environmental water testing. Students will become familiar with a variety of water quality tests used by environmental scientists to monitor the quality of our water resources and the health of fresh water aquatic ecosystems. Students will be assigned and research one or two water quality tests. The research part of the project will involve students investigating substances in water and describing one or more of these substances in terms of:

- An aspect of chemistry of the substance(s) being tested for, e.g.
    - "If the substance is a pollutant, what is it used for?"
- An affect and/or role of the substance(s) in aquatic ecosystems, e.g.
    - "Does it occur naturally? How do amounts of the substance benefit the ecosystem?"
- An acceptable range of measured amounts for a healthy aquatic ecosystem;
- A description of negative effects on aquatic ecosystems when the substance(s) is/are above and/or below acceptable ranges, e.g.
    - "What will be the short term effects? The long term effects?"
- Identifying substance sources(s) and ways the substance(s) enter into aquatic ecosystems.
- Proposed actions to prevent or reduce the release of the substance(s) into our aquatic system.

The WQTP engages students in four series of WQTP lessons designed over a six to eight week project period. Each lesson is sequential in terms of building a level of understanding for students of water quality monitoring practices. Through this sequence of lessons, students will become familiar with West Struve Slough, and learn how to effectively monitor its water quality. An outcome of this project will allow students to share their project information with a local water management agency. In this way, students will have an opportunity to become proactive with respect to managing a precious natural resource, our local wetlands.

WETLANDS WATER QUALITY TESTING PROJECT
INTRODUCTORY LESSON #1

Summary:
Water quality testing of local wetland waters introduces students to environmental water quality issues and affects of effluents into these waters. West Struve Slough serves as a local wetland water body adjacent to a high school campus. This lesson will begin with a general discussion of water quality and why it is important to the coastal ecosystem, particularly West Struve Slough. Students will be introduced to water quality testing practices and applications on West Struve Slough waters. Students will conduct a research project over an extended period of time (eight to ten weeks), and through this project they will be introduced to fundamental chemistry concepts including parameters of pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity. Students will explore how substances, naturally occurring or introduced, affect these parameters and contribute to a balanced or unbalanced aquatic ecosystem.

Subject Area(s): Chemistry

Grade Level(s): 10th grade

Lesson Duration/Instructional Sequence:
- 2 class periods or one block period
- Field trip preparatory activity.
- Structured as part of an eight-ten week project (quarter project or grading period project)

California Content Standards:
Chemistry

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:
   a. Students know the observable properties of acids, bases, and salt solutions.
   d. Students know how to use the pH scale to characterize acid and base solutions.
8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept:
   a. Students know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
   b. Students know how reaction rates depend on such factors as concentration, temperature, and pressure.

Assessment:
- Students will respond to one or more prompts on their graphic organizer and share their responses with other class members.
- Students will complete a vocabulary research graphic organizer to determine their prior knowledge with respect to substances tests in water.

- A table product graphic organizer may be collected as a form of group assessment and/or each group may state one or more of their findings as a class discussion.
- An assessment may be conducted at the conclusion of the "Power Point" presentation. This may be in the form a response to a prompt, e.g. " I learned that water quality is tested in the following way:"

Learning Objectives:

Through this project students will be introduced to environmental water testing. The project is designed for a period of eight to ten weeks. This first lesson introduces students to water quality monitoring practices and their application to a local wetland, West Struve Slough. During this time students will begin to become familiar with a variety of water quality tests that are used by environmental scientists. These "tests" are designed to monitor the quality of our water resources and the health of fresh water aquatic ecosystems. Students will research on an assigned parameter or parameter set used in water quality tests.

During these research activities, students will:

1. Describe the chemistry of the substance(s) being tested for and its use and potential as a environmental pollutant.
2. Describe the effect and/or role of the substance(s) in aquatic ecosystems, determine if it is naturally occurring, and in what way it may or may not be beneficial.
3. Describe negative effects on aquatic ecosystems when the substance(s) is/are above and/or below acceptable ranges, as well as short term and/or long term effects.
4. Describe sources of the substance(s) and the ways that the substance(s) find their way into aquatic ecosystems.

Equipment, Materials, and Resources:

- Selected items from Chemistry Lesson #2 Equipment and Materials list for demonstration use only
- Water test kits from Chemistry Lesson #2 Equipment and Materials list for demonstration use only

Lesson Narrative / Procedure:

In order to find information regarding the water test(s), students will need to do independent research and will need to find and cite information from both the library and the internet. Citations need to be properly noted in a bibliography. (See Appendix #7, "References" for background data on water quality analysis, data profile, and parameter information.)

The second part of the research project involves student testing the water from West Struve Slough for the water test(s) they have been assigned. The first data for this part of the research project will be obtained on a chemistry field trip to West Struve Slough. All of the water tests that students are assigned to research will be tested on the field trip and data for each class's data will be entered into a database, which will be used by students in their projects. Students will be assigned one more test that they will have to schedule and conduct on their own with a partner over the next 4-5 weeks. Students will use their own data as well as the class data to analyze the quality of water in the wetlands ecosystem. Students will need to perform some simple statistics and graph their data

as part of their analysis. Student will also write a conclusion to describe the health of the wetlands aquatic ecosystem with regards to their test(s) which includes recommendations to improve and/or preserve the water quality in West Struve Slough.

The data that results will be available to interested agencies and citizen monitoring groups. The following is the list of tests that will be conducted:

- pH
- dissolved oxygen
- nitrates and ammonia
- phosphates
- temperature
- conductivity
- turbidity

This may be done in one single 110-minute block or split into 2 55-minute blocks. It begins with a general discussion of water quality and why it is important to the coastal ecosystem.

Meaningful Experience: In order to pre-assess students' prior knowledge, they will share amongst their peers a perception they have of substances found in water and potential water pollutants, This may be accomplished by a cooperative learning strategy where students think about a specific prompt.

1. Teacher introduces the basic vocabulary associated with water quality testing. As an activity to prepare for the field trip, students will complete a vocabulary research graphic organizer to determine their prior knowledge with respect to substances tests in water (see App. #5 or "Water Quality Conditions and Vocabulary"). Students will respond to one or more prompts on their graphic organizer and share their responses with other class members.

2. Ask students to think about a list of substances and/or parameters that are tested in water to determine water quality. These are parameters of pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity.
    - Students are asked to write briefly about as many of these parameters that they are familiar with and they may include:
        i. An aspect of chemistry of the substance(s) being tested for, e.g. "If the substance is a pollutant, what is it used for?"
        ii. An affect and/or role of the substance(s) in aquatic ecosystems, e.g. "Does it occur naturally and if so, how does the ecosystem benefit from natural amounts of the substance?"
    - Students may share their written responses with table group members (total time 15 minutes/*think-pair-share*)

3. Students research one or more of the listed substances or parameters that are to be tested during water quality monitoring activities. This research may be accomplished by providing written information regarding each substance or parameter, i.e. pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity (see Appendix #7 "References"). Advanced teacher preparation time of 2 hours should be allowed for gathering appropriate information.

4. A cooperative learning activity of "Jig Saw" may be applied to allow individual groups of students to become "experts" on a particular parameter.
    a. Table groups of seven students (4 or 5 groups total) are formed (5 min.).
    b. Each student in a group is assigned to a region of the classroom where information is available regarding a particular parameter (3 min.)
    c. Students from each group move to their "research areas" to learn about their assigned parameter (3 min.). This would create 7 "research stations" with 4 or 5 students per station.
    d. At these "stations" students read and discuss information about their assigned parameter (10 minutes). Student "experts" use their graphic organizer to gather information and state responses to each listed question.
    e. Experts return to their original group of 7 students, and each "expert" shares her/his responses to each graphic organizer question (15 min). A recorder for each table group writes information onto a common table group graphic organizer.
    f. This table product may be collected as a form of group assessment and/or each group may state one or more of their findings as a class discussion.

5. Teacher to present a PowerPoint presentation about a sample field trip to West Struve Slough to collect water quality samples. (See *PVHS Water Quality Testing Project Power Point*)
    a. This presentation will introduce the research project that students will be completing during the rest of the quarter.
    b. The presentation also introduces important chemistry concepts including the parameters of pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity, and how these substances interact to create a balanced, or unbalanced, ecosystem.

       Total presentation time including question/answer and/or class discussion (30 min.) An optional assessment may be conducted at this time.

Meaningful Experience: Assess students' knowledge and attitudes about a field site or event prior to the field visit to determine misconceptions and misgivings or fears, from NOAA California Bay Watershed Education and Training Program.

References:

- WQTP Appendix #6: *PVHS Water Quality Testing Project Power Point*
- Extension Activities beyond classroom: "As a class, join the Globe Program (www.glove.gov). You can collect wetland data and post it on the web…"
- Graphic Organizer: WERC Water Quality Testing Lab
- WQTP Appendix #7: References/General Information and Data Source

WETLANDS WATER TESTING PROJECT
WATER TEST KIT ORIENTATION LESSON #2

Summary:
Water quality testing of local wetland waters introduces students to environmental water quality issues and affects of effluents into these waters. West Struve Slough serves as a local wetland water body adjacent to the Pajaro Valley High School campus. This lesson will allow students to practice conducting chemical tests on water solutions in preparation for a hands-on activity out on the field. Concepts of standard solutions and controls will be presented as well. These testing practices will allow for a comparison of controls with standard solutions, and an orientation of accepted chemical test practices. Students will conduct a research project over an extended period of time (eight to ten weeks), and through this project they will be introduced to fundamental chemistry concepts including parameters of pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity. Students will explore how substances, naturally occurring or introduced, affect these parameters and contribute to a balanced, or unbalanced aquatic ecosystem.

Subject Area(s): Chemistry

Grade Level(s): 10th grade

Lesson Duration/Instructional Sequence:

- Two classroom periods
- Classroom or nature center lab practice as a preparatory for field trip.
- Structured as a six-eight week project (quarter project or grading period project)

California Content Standards:

Chemistry

Investigation and Experimentation Standards

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:
   b. Identify and communicate sources of unavoidable experimental error.
   c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
   d. Formulate explanations by using logic and evidence.
   j. Recognize the issues of statistical variability and the need for controlled tests.

Acids and Bases

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:
   a. *Students know* the observable properties of acids, bases, and salt solutions.

Solutions

6. Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:
    a. *Students know* the definitions of *solute* and *solvent.*
    c. *Students know* temperature, pressure, and surface area affect the dissolving process.

Assessment:

- Students will record predictions for chemical test results for a control: distilled water.
- Successful completion of the **Water Quality Monitoring Test Kit Orientation** hand out
- An assessment may be conducted at the conclusion of the Water Test Lab. This may be in the form a response to a prompt, e.g. " I learned that water quality is tested in the following way:"

Learning Objectives:

Through this project students will be introduced to environmental water testing. The project is designed for a period of eight to ten weeks. This second lesson introduces students to water quality monitoring practices and their application to a local wetland, West Struve Slough. During this time students will orient themselves to water quality test kit use.

1. Students will learn to use specific water test kits for water identified water quality parameters (Dissolved oxygen, Nitrate, Phosphate, pH, and Turbidity).
2. Students will be able to predict chemical test results for a control (distilled water), and will conduct chemical tests (trials) on known substances (standards) in water solutions.

Meaningful Experience: Assess students' knowledge and attitudes about a field site or event prior to the field visit to determine misconceptions and misgivings or fears.
(from NOAA California Bay Watershed Education and Training Program.)

Equipment, Materials, and Resources:

- For data collection: Pencils, Water Quality Monitoring Test Kit Orientation hand out,
- Background information on testing protocols and parameters (See **Water Quality Testing Project References & Resources**)
- "Control" samples of distilled water
- Set of solution standards: phosphate, nitrate, dissolved oxygen, pH and turbidity.
- La Motte Low-cost Water Quality Test Kits containing the following: Test tabs for nitrates, phosphates, pH, and dissolved oxygen, temperate strip, turbidity gauge, description and instructions.
- Winkler Dissolved Oxygen kit in blue box (LaMotte or equivalent/optional) – four reagents, collection bottle, titration equipment (NOTE: This kit contains dangerous chemicals including sulfuric acid and should ONLY be used under the direct supervision of an accredited chemistry teacher. Do NOT include this kit if it will be used by unsupervised students).

For Chemical Test guidelines, refer to:
LaMotte Testing Methods- http://www.lamotte.com/pages/common/techtips/testmeth.html
Dissolved Oxygen- http://www.lamotte.com/pages/common/techtips/dotip.html
Turbidity- http://www.lamotte.com/pages/common/techtips/turbidit.html
Preparing Dilute Standards- http://www.lamotte.com/pages/common/techtips/turbidit.html

Lesson Narrative / Procedure:

This lesson will begin with a general discussion of water quality test parameters and how these parameters are measured by chemical testing. Teacher should use the resources in Appendix 7 to assist in this discussion.

Next, divide students into the following data collection groups:

- pH
- dissolved oxygen + temperature
- nitrates
- phosphates
- turbidity + conductivity

Each group will practice techniques for testing these water quality parameters using the La Motte water quality test kits and instructions.
(Allow 55 min. for steps 1-3)

1. Groups should take a few minutes to become familiar with their water quality testing procedure by going over the La Motte instructions.
2. Students perform water tests on control sample (distilled water)
3. Students perform water tests on a standard solution
4. Repeat test 3 times to establish a set of trial test data for each parameter.
5. Students compare chemical test data results from controls with standard solutions.
6. Students will report each assigned parameter test result onto a common **Water Quality Monitoring Test Kit Orientation** hand out
7. Groups should record final data onto an overlay and present results to the rest of the class. Students should suggest sources of error for control and/or standard data.

Optional Activity 1: Students may research the assigned parameter and determine its accepted level range in water quality monitoring practices. This research may be accomplished by providing written information regarding each substance or parameter, i.e. pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity (see Appendix #7 "References"). Advanced teacher preparation time of 2 hours should be allowed for gathering appropriate information.

Optional Activity 2: The class may view the video "An Introduction to Water Resource Solutions" produced by the Watsonville Wetlands Watch or schedule a visit from a City of Watsonville Public Works technician or Pajaro Valley School District/ Maintenance & Operations representative to talk about aspects of bio or water-quality monitoring that apply to a region surrounding and/or including the high school campus.

Meaningful Experience: Allow students to practice skills (use new equipment and procedures) at a familiar site (classroom or nature center lab) before a field experience.

- Extension Activities beyond classroom: "As a class, join the Globe Program (www.glove.gov). You can collect wetland data and post it on the web…"
- WQTP Appendix #6: Chemical Test Kit Orientation Data Sheet
- WQTP Appendix #7: References/General Information and Data Source
- **LaMotte Company,** PO Box 329, 802 Washington Avenue, Chestertown, MD 21620 – USA, tech@lamotte.com

WETLANDS WATER TESTING PROJECT
FIELD TEST LESSON #3

Summary:
Water quality testing of local wetland waters introduces students to environmental water quality issues and affects of effluents into these waters. West Struve Slough serves as a local wetland water body adjacent to a high school campus. This lesson will provide students with opportunities to field test water taken from selected location sites in West Struve Slough. Students will implement water quality testing practices and applications for seven identified water quality parameters. Students will contribute to a long-term research project of Slough waters by providing evidence and understanding of pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity parameters. Chemical tests of these parameters will continue over a three week period such that students may generate a chemical profile for the Slough. This parameter profile will be compared to other water quality test data so that students
may understand how substances, natural occurring or introduced, affect these parameters and contribute to a balanced or unbalanced aquatic ecosystem.

Subject Area(s): Chemistry

Grade level(s): 10th

Lesson Duration/Instructional Sequence:

- One 55 – 70 minute period (field testing) repeated each week for three week period.
- Structured as part of six-eight week project (quarter project or grading period project).

California Content Standards:

Chemistry

Investigation and Experimentation Standards

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, students should develop their own questions and perform investigations. Students will:
    b. Identify and communicate sources of unavoidable experimental error.
    c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
    d. Formulate explanations by using logic and evidence.
    j. Recognize the issues of statistical variability and the need for controlled tests.

Acids and Bases

5. Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:
a. *Students know* the observable properties of acids, bases, and salt solutions.

Solutions

6. Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:

a. *Students know* the definitions of *solute* and *solvent.*

c. *Students know* temperature, pressure, and surface area affect the dissolving process.

Reaction Rates

8. Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept:

a. Students know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

b. Students know how reaction rates depend on such factors as concentration, temperature, and pressure.

Assessment:

- Students will conduct chemical tests (trials) on water samples from West Struve Slough.
- Students will record chemical test results onto a **Water Quality Monitoring/ Data Sheet**. (see Appendix 2, Field Test Data Sheet)
- Students will compare chemical test results of field tests with solution standards and "control" values.
- Students will chart parameter data in a graphic form (data versus time period).
- Student groups may state one or more of their findings as a class discussion.
- Students may account for patterns in data which may suggest how substances or environmental factors, natural occurring or introduced, affect these parameters.

Learning Objectives:

Through this project students will be introduced to environmental water testing. The project is designed for a period of eight to ten weeks. This third lesson implements water quality monitoring practices and allows students to apply their water testing skills in a field application. During this time students will orient themselves to field test sites in West Struve Slough and apply water quality test kit use at those sites.

3. Students will use specific water test kits for water identified water quality parameters (Dissolved oxygen, Nitrate, Phosphate, pH, and Turbidity).
4. Students will apply test kit procedures to water samples taken from West Struve Slough.
5. Students will complete a Water Quality Monitoring/ Data Sheet by recording chemical test data for tested water samples (Appendix 2).
6. Each individual or group may state one or more of their findings during class discussion. Students may account for patterns in data which may suggest how substances or environmental factors, natural occurring or introduced, affect these parameters.
7. *During these chemical test activities, students may:*

- Describe the chemistry of the substance(s) being tested for and its use and potential as an environmental pollutant.
- Describe the effect and/or role of the substance(s) in aquatic ecosystems, determine if it is naturally occurring, and in what way it may or may not be beneficial.
- Describe negative effects on aquatic ecosystems when the substance(s) is/are above and/or below acceptable ranges, as well as short term and/or long term effects.

- Describe sources of the substance(s) and the ways that the substance(s) find their way into aquatic ecosystems.

Meaningful Experience Provides each student with at least two field experiences in the local watershed
Meaningful Experience: Allows students to investigate local environmental issues through their own or an ongoing project.
(from NOAA California Bay Watershed Education and Training Program.)

For information regarding water quality testing practices, refer to Appendix Resources & References. Information about pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity parameters is provided in **Water Quality Monitoring and Test Parameters**. This information identifies testing protocol and significance for each parameter with relation to water quality.

Equipment, Materials, and Resources: (See Field Trip Checklist)

1. Data collection: Clip boards, pencils, waterproof data sheet (Appendix 2), background information on testing protocols and parameters.
2. Bottles rinsed with distilled water.
3. Water Quality Testing Kits: Use selected chemical "Test Kits" from WQTP Material& Equipment list for student test use including Dissolved oxygen, Nitrate, Phosphate, pH, and Turbidity tests as well as temperature and conductivity tests.

   "Test Kits" Containing the following: Blue plastic thermometers and/or LaMotte low cost testing kit (white container with lid, thermometer on side) for temperature measurements.
   - Nitrate kit containing tube with lid, two packet of tablets (for part 1 and part 2), and results card;
   - Phosphate kit containing tube with lid, packet of tablets, and results card;
   - Dissolved oxygen kit containing tube with lid, packet of tablets, and results card;
   - pH kit containing litmus paper in box with lid closed, tube with lid, packet of tablets, and results card;
   - Turbidity kit containing either a LaMotte low cost testing kit (white container with lid, with Secchi pattern at that bottom) or small stand up graduated cylinder, and results card;
   - Winkler Dissolved Oxygen kit in blue box (LaMotte or equivalent/optional) – four reagents, collection bottle, and titration equipment (NOTE: This kit contains dangerous chemicals including sulphuric acid and should ONLY be used under the direct supervision of an accredited chemistry teacher. Do NOT include this kit if it will be used by unsupervised students).

Lesson Narrative / Procedure:

Meaningful Experience: Provides each student with at least two field experiences in the local watershed

Students will participate in a water quality collection field trip to West Struve Slough with their instructor, and if possible, docent volunteers and/or staff from Watsonville Wetlands Watch. Students will divide into groups based on which "substances" (parameter) they are researching or "substances" that they have learned to chemically test during WQTP Lesson #2. Tested parameters will include pH, dissolved oxygen (DO), nitrates and ammonia, phosphates, temperature, conductivity, and turbidity.

Each student group will collect water samples from identified sites at West Struve Slough. For each water sample a group will apply a chemical test technique for their "substance". In addition, students will make observations and inquiries about the environmental conditions of West Struve Slough including soil type, weather conditions, time of day, time of year, litter, etc. that might influence their results. All observations and data will be recorded on a data sheet provided by the instructor and included in this guide (Appendix 2).
All of the water tests that students are assigned to research will be tested on the field trip and data for each class will be entered into a database. This database may be used by students in their research projects. Two additional field tests will occur (one per week) such that a three week sampling period exists for this "field component".

(Optional activity) Students may be assigned one more tests that they will schedule and conduct on their own with a partner over a 4-5 weeks time period. Students will independently obtain Sough water samples and conduct chemical tests on these samples. Data obtained from these tests will serve as a supplement to the three week database "field component". This option may be applied only if student supervision is not mandatory and/or health and safety of students is not compromised.

Meaningful Experience: Allows students to investigate local environmental issues through their own or an ongoing project.

Project Report Preparation (Following each field trip, allow classroom time for sharing data.)
Students will use their own data as well as class data to analyze wetland water quality and its contribution to the wetlands ecosystem. Students will need to perform some simple statistics and graph their data as part of their analysis. Student will also write a conclusion to describe the health of the wetlands aquatic ecosystem with regards to their researched "substance(s)" or parameter, and will include recommendations to improve and/or preserve the water quality in West Struve Slough.

References:

1. WQTP Appendix 2, Field Test Data Sheet
2. WQTP Appendix 3, Field Trip Checklist
3. WQTP Appendix #8: *PVHS Water Quality Testing Project Power Point*
4. WQTP Appendix #7: References/General Information and Data Source

5. **LaMotte Company,** PO Box 329, 802 Washington Avenue, Chestertown, MD 21620 – USA, tech@lamotte.com

   Extension Activities beyond classroom: "As a class, join the Globe Program (www.glove.gov). You can collect wetland data and post it on the web…"

WETLANDS WATER TESTING PROJECT
FIELD TEST LESSON #4

Summary :
Water quality testing of local wetland waters introduces students to environmental water quality issues and affects of effluents into these waters. West Struve Slough serves as a local wetland water body adjacent to a high school campus. This fourth and concluding lesson will provide students with opportunities to share information about West Struve Slough Waters and contribute to an understanding of local wetlands. Students will be able to develop recommendations on how to improve and/or preserve the water quality in West Struve Slough. Student will be able to interact with a professional representative from a water agency and reflect on their project as it applies to local water management practices. Students will discuss their observations from field testing and propose how substances, natural occurring or introduced, affect these parameters and contribute to a balanced or unbalanced aquatic ecosystem.

Subject Area(s): Chemistry

Grade levels: 10th

Lesson Duration/Instructional Sequence:

- one 55 – 70 minute period
- Structured as part of six-eight week project (quarter project or grading period project).

California Content Standards:

Chemistry

Investigation and Experimentation Standards

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, students should develop their own questions and perform investigations. Students will:
    b. Identify and communicate sources of unavoidable experimental error.
    c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
    d. Formulate explanations by using logic and evidence.
    j. Recognize the issues of statistical variability and the need for controlled tests.

Assessment:

- Students will analyze chemical test data from water samples of West Struve Slough.
- Students will compare chemical test results from a West Struve Slough Water Quality Monitoring/ Database with their test results taken over a three-week period.
- Student groups may state one or more of their findings as a class discussion.

- Students may account for patterns in data which may suggest how substances or environmental factors, natural occurring or introduced, affect these parameters.

Learning Objectives:

Through this project students will be introduced to environmental water testing. The project is designed for a period of eight to ten weeks. This fourth lesson applies water quality monitoring data to an analysis of wetland waters (West Struve Slough), and it allows students to apply their knowledge and understanding of water quality.

During these classroom discussions, students may:

- Describe the chemistry of the substance(s) being tested for and its use and potential as an environmental pollutant.
- Describe the effect and/or role of the substance(s) in aquatic ecosystems, determine if it is naturally occurring, and in what way it may or may not be beneficial.
- Describe negative effects on aquatic ecosystems when the substance(s) is/are above and/or below acceptable ranges, as well as short term and/or long term effects.
- Describe sources of the substance(s) and the ways that the substance(s) find their way into aquatic ecosystems.

Meaningful Experience: Through this project, students are able to learn and apply new knowledge.

Meaningful Experience: This project allows students to contribute in some way to the betterment of their community through their own or an ongoing project.
(from NOAA California Bay Watershed Education and Training Program.)

Background:

For information regarding water quality testing practices, refer to Appendix Resources & References. Information about pH, temperature, dissolved oxygen, nitrates, phosphates, conductivity, and turbidity parameters is provided in **Water Quality Monitoring and Test Parameters** hand out. This information identifies testing protocol and significance for each parameter with relation to water quality.

Equipment, Materials, and Resources:

1. **Water Quality Monitoring** Database for West Struve Slough
2. Appendix 2, Field test Data Sheet (class data)
3. Appendix 6, Test Kit Orientation Data Sheet (class data)
4. Appendix 7, References & Resources

Lesson Narrative / Procedure:

Project presentation and guest speaker (90 min. block period):
Students will contribute to a water quality information-sharing session. With their instructor, and if possible, docents, volunteers and/or staff from Watsonville Wetlands Watch, students will share their data about "substances" (parameters) they have researched in waters of West Struve Slough. Tested parameters will include pH, dissolved oxygen (DO), nitrates and ammonia, phosphates, temperature, conductivity, and turbidity.

Meaningful Experience: Through this project, students are able to learn and apply new knowledge.

Each student group presents information about a particular water quality parameter. Students will discuss their observations from field test and propose how substances, natural occurring or introduced, affect these parameters and contribute to a balanced or unbalanced aquatic ecosystem. Student will also describe the health of the wetlands aquatic ecosystem with regards to their researched "substance(s)" or parameter, and will include recommendations to improve and/or preserve the water quality in West Struve Slough. (Allow five minutes per group/ 35 min.)

Meaningful Experience: This project allows students to contribute in some way to the betterment of their community through their own or an ongoing project.

Guest Speaker

A representative from a local water management agency or a water quality industry will present a perspective of water quality monitoring as it may apply to local wetland waters. Students will have an opportunity to share their research projects with the representative, and they will be able to compare their project with local water management practices. Sources for local guest speaker representatives are: (allow 30 min for presentation and Q & A. See References)

- City of Watsonville Public Works
- Soquel Creek Water District
- Pajaro Valley Water Management Agency

References:

6. WQTP Appendix #8: *PVHS Water Quality Testing Project Power Point*
7. WQTP Appendix #7: References/General Information and Data Source
8. City of Watsonville Public Works (http://www.ci.watsonville.ca.us/publicworks/index.htm)
9. Pajaro Valley Water Management Agency (http://www.pvwma.dst.ca.us/)
10. Soquel Creek Water District (http://www.soquelcreekwater.com/)
11. Extension Activities beyond classroom: "As a class, join the Globe Program (www.glove.gov). You can collect wetland data and post it on the web…"

Water Quality Conditions and Vocabulary

Substance to be tested	What does test tell us?	Where does this substance come from?	How may test results show poor water quality?
Nitrate			
Phosphate			
pH			
Temperature			
Turbidity			
Dissolved oxygen (DO)			

WATER QUALITY MONITORING TEST KIT ORIENTATION

Name _____Date _____Location _____

Fill in the results of your water testing below:

Water Parameter	Trial #1 Standard	Trial #2 Standard	Trial #3 Standard	AVG. Standard	Control	Comment
Dissolved Oxygen ppm vs % sat						
Nitrate ppm						
Phosphate ppm						
pH acid/1-10/base						
Temperature C						
Turbidity JTU						
Conductivity						

Phosphate: _____ppm_____ppm_____ppm

Nitrate: _____ppm _____ppm _____ppm

pH: acid 4 5 6 7 8 9 10 base acid 4 5 6 7 8 9 10 base acid 4 5 6 7 8 9 10 base

Temp. (C)_____ (C)_____ (C)_____

Turbidity: _____JTU _____JTU _____JTU

Diss. Oxygen: _____ppm _____ppm _____ppm _____% saturation

Now average each group's test results. Fill in your answers on the lines below:

Nitrate _____ Turbidity_____

pH _____ Dissolved Oxygen_____

Temperature _____

How much is that in F? F = (C x 1.8) + 32 =
F = (_____ x 1.8) = _____ + 32 = _____ F

	What does the test tell us? (use your water vocabulary handout)	Normal range for animals to survive	My test result	Mark if *your* test result was IN RANGE or OUT OF RANGE	Group Average test result	Mark if *the group average* was IN RANGE or OUT OF RANGE
Nitrate		Less than 1				
Phosphate		Less than 1				
pH		6.5 to 8.2				
Dissolved oxygen		At least 5 or 6				

How much is that in F? F = (C x 1.8) + 32 =

F = (_____ x 1.8) = _____ + 32 = _____ F

Water Quality Monitoring

Name _____Date _____Location _____

Fill in the results of your water testing below:

Phosphate: _____ppm

Nitrate: _____ppm

pH: circle one: **acid** 4 5 6 7 8 9 10 **base**

Temperature: _____degrees Celsius (C)

How much is that in F? F = (C x 1.8) + 32 =

F = (_____ x 1.8) = _____ + 32 = _____ F

Turbidity: _____JTU

Dissolved Oxygen: _____*ppm* _____*% saturation*

Now average each group's test results. Fill in your answers on the lines below:

Phosphate _____

Nitrate _____

pH _____

Temperature _____

Turbidity _____

Dissolved Oxygen _____

	What does the test tell us? (use your water vocabulary handout)	Normal range for animals to survive	My test result	Mark if *your* test result was IN RANGE or OUT OF RANGE	Group Average test result	Mark if *the group average* was IN RANGE or OUT OF RANGE
Nitrate		Less than 1				
Phosphate		Less than 1				
pH		6.5 to 8.2				
Dissolved oxygen		At least 5 or 6				

Water Testing Field Trip Checklist

Advanced Preparation:

Requests for Docent assistant from the Fitz WERC – 3 weeks in advance
Photocopy Water Testing Project
Globe Data Tables

Materials:

Clip Boards
GPS
Data Tables
Test Kits (LaMotte or comparable low-cost test kits)

- Temperature
- Nitrate
- Phosphate
- Dissolved Oxygen
- pH (chemical test and Universal Litmus)
- Turbidity

Tasks to do in the Classroom:

Divide Students into groups (ahead of time)
Student Tasks:
2 Testers (read and conduct tests)
At least 2 Recorders (record data from test and get/share with other groups)

Expectations for the Field Trip

Class Groups: 5 Groups per class
31-35 students – 7 students per group
26-30 students – 6 students per group
21-25 students – 5 students per group

Field Team Managers (Teacher and Docents/Volunteers)
Teacher Manages 3 Teams
Docent/Volunteers 2 Team Each

WATER QUALITY TESTING PROJECT
REFERENCES & RESOURCES

Curriculum Resources & Professional Development:

1. American Chemical Society (ACS), Chemistry in the Community (ChemCom),

- Chem Com Teacher Training Workshops

(http://portal.acs.org/portal/acs/corg/content?_nfpb=true&_pageLabel=PP_ARTICLEMAIN&node_id=1146&use_sec=false)

- Chem Com Teacher Resources

(http://www.lapeer.org/chemcom/)

2. Urban Education Partnership, "Target Science"
(http://www.urbanedpartnership.org/target.html)

- "What's in the Water? Activities Using Computer-based Labs with Probes to Acquire Data"

(http://www.urbanedpartnership.org/target/technology/secondary/water/index.html)

3. Kentucky Water Ways, "Chemical Testing Project Goals"
(http://www.state.ky.us/nrepc/water/wcgoals.htm)

General Information and Data Source:

1. Environmental Protection Agency (EPA),

- "Drinking Water Standards for Regulated Contaminants"

(http://www.epa.gov/ogwdw/therule.html#Surface)

- "Drinking Water Contaminants"

(http://www.epa.gov/safewater/contaminants/index.html#ucmr)

- "Ground Water & Drinking Water/ Frequently Asked Questions"

(http://www.epa.gov/ogwdw/faq/faq.html)

2. Environmental Working Group (EWG), "A National Assessment of Tap Water Quality"
(http://www.ewg.org/tapwater/findings.php)

3. Water Quality, Wikipedia Encyclopedic Reference
(http://en.wikipedia.org/wiki/Water_quality)

Water Quality Monitoring and Test Parameters:

1. Dissolved Oxygen, "Why is testing dissolved oxygen important?"
(http://www.state.ky.us/nrepc/water/wcpdo.htm)

2. Nitrogen, "Why are nitrate, nitrite, and nitrogen testing important?
(http://www.state.ky.us/nrepc/water/wcpno.htm)

3. Phosphorous, "Why is phosphorous important?"(http://www.state.ky.us/nrepc/water/wcpph.htm)

4. Temperature, "Why is temperature testing important?

(http://www.state.ky.us/nrepc/water/wcptmp.htm)

5. Water pH, "Why are water pH levels important to test?
(http://www.state.ky.us/nrepc/water/wcpph.htm)

6. Turbidity Water Test, "Why test for turbidity in water?/ Water Quality and the Los Angeles River"
(http://www.urbanedpartnership.org/target/units/river/tour/turbidity.html)

Water Quality Testing Protocols & Research

1. U.S. Tap Water Quality Data Base, EWG

- "National Contaminant Report/ Nitrate"

(http://www.ewg.org/tapwater/contaminants/contaminant.php?contamcode=1040)

- "National Contaminant Report/ Phosphate"

(http://www.ewg.org/tapwater/contaminants/contaminant.php?contamcode=1043)

2. Water Quality Analysis Parameters
(http://www.aecos.com/aecoswq.html)

3. Water Quality Monitoring, Duke University/Department of Chemistry
(http://www.chem.duke.edu/~jds/cruise_chem/water/Bib.html)

4. Water Quality Test Protocols, 20 Rivers near Hong Kong, China
(http://www.epd.gov.hk/epd/misc/river_quality/1986-2005/textonly/eng/pdf/Appendix%20B.pdf)

6. Wilkes University, "Nitrates and Nitrites in Drinking Water"
(http://www.water-research.net/nitrate.htm)

WATER TESTING PROCEDURES/TEST STEPS

Dissolved oxygen (DO)

1. Turn on probe
2. Place probe in water
3. Read measurement in %
4. Record results.

Nitrate

1. Fill a test tube to the 5ml line with sample water.
2. Add one Nitrate #1 TesTab.
3. Cap the tube and shake until the tablet has disintegrated.
4. Add one Nitrate #2 CTA TesTab.
5. Cap the tube and shake until the tab has dinintegrated.
6. Wail 5 minutes.
7. Compare the color of the sample to the nitrate color chart.
8. Record your results (in ppm)

pH

1. Fill test tube to the 10 ml line with sample water.
2. Add 1 pH wide range TesTab.
3. Cap the tube and shake until tablet has disintegrated.
4. Compare color of the sample to the pH color chart.
5. Record your result.

Turbidity

1. Fill the turbidity tube to the line.
2. Place the base of the tube on the turbidity color chart.
3. Look down through the sample water at the Secchi Disk icon (black and white pattern).
4. Compare the appearance of the Secchi Disk icon under the tube to the gray Secchi Disks on either side of the tube to determine the turbidity.
5. Record your results (in JTU)

Phosphate

1. Fill the test tube to the 5 mL line.
2. Add one Phosphorous TestTab.
3. Cap the tube and mix until the tab has disintegrated.
4. Wait 5 minutes (use timer)
5. Compare the color of the sample to the Chart. Record your result on your worksheet.