Unit Title: *Water Quality*
Subject/Target Grades: *8th Grade Science*

Unit Summary

This unit will inform students about several parameters frequently measured for typical water quality analysis in streams. These include pH, dissolved oxygen, specific conductivity, and macroinvertebrates. Each lesson has an accompanying lab exercise that will provide students with hands on experience measuring these parameters in order to understand how they influence stream water quality. The introductory PowerPoints introduce each parameter in depth, and describe how they are used to assess water quality, what affects their measurement and how they are typically measured.

The first lesson is an introduction to each of the widely used parameters and the definition of water quality in a stream. A video is shown that students will discuss in class at the end of the lesson. This is meant to introduce them to reasons water quality is affected, and that it is something of extreme importance. The subsequent lessons will teach students the fundamentals behind sampling for the parameter of topic. At the end of the activity, students will be able to define each parameter and measure it using the proper equipment. Most of the lessons include identifying relationships of the parameter of topic with varying properties that affect their values. These relationships are visualized through graphing exercises and questions to reinforce the knowledge are asked at the end of each lab. Due to the need to know a little bit of chemistry for a complete understanding of how each water quality parameter works, core ideas in chemistry are integrated into each lesson including the definition of an ion, the visitation of the Periodic Table and atomic number, electrons, protons and neutrons, an introduction to chemical bonding (hydrogen bonds), and the molecular structure of water. The unit culminates in a field trip where students will use sampling equipment to measure the pH, specific conductivity, dissolved oxygen and temperature of a local or nearby stream. Additional analysis of macroinvertebrates are conducted using leaf litter packets. For the development of this unit, the locality was used as an advantage and water sampling of two rivers are compared for differences in water quality parameters, whereby one stream is the discharge point of a sewage treatment plant. However the field trip can be designed to conform to the teachers' local environment.

*Required knowledge includes basic understanding of the water cycle, knowledge of the Periodic Table, Atomic Number, Electrons, Protons and Neutrons, and graphing.

Next Generation Science Standards:

MS-ESS2 – Earth Systems

Lesson 1, 2, 3, 4, 5	
ESS2.C	*The Roles of Water in Earths Process*
	• Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4) • Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2)

MS-LS2 – Matter and Energy in Organisms and Ecosystems

Lessons 1, 2, 3, 4, 5, 6	
MS-LS2-1.	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations

MS-PS1 – Chemical Reactions

Lessons 2, 3, 4	
MS-PS1-2.	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Learning Objectives:

- Students will identify key water quality parameters that are used in stream chemistry analysis
- Students will define pH both chemically and by using the pH scale
- Students will identify acids and bases
- Students will measure pH using Litmus Paper
- Students will graph the relationship between the pH of an acid or a base and the amount of dilution.
- Students will define dissolved oxygen
- Students will relate dissolved oxygen to temperature via measurement in a lab exercise and graphing
- Students will measure dissolved oxygen chemically using tablets (or a sensor can be used)
- Students will describe what naturally occurring elements affect dissolved oxygen
- Students will describe how dissolved oxygen affects aquatic life, specifically fish populations
- Students will define specific conductivity
- Students will define an ion and describe how the concentration of ions affects the conductivity of a solution
- Students will measure specific conductivity using multimeters
- Students will define an electrolyte – both strong and weak
- Students will define the relationship between the concentration of ions and the conductivity of a solution through graphing results from lab experiments
- Students will define a macroinvertebrate
- Students will learn how to identify macroinvertebrate based on physical characteristics
- Students will define the 3 pollution groups that contain distinct macroinvertebrate populations
- Students will identify the pollution extent of a river based on macroinvertebrate populations
- Students will identify what affects macroinvertebrate populations
- Students will conduct a field activity where they sample water quality from 2 different streams

Lesson Title- Brief Description	Learning Objectives	NGSS Addressed (codes)	Materials
Lesson 1: What is Stream Quality Students will be introduced to what stream quality is and the parameters that are frequently used to determine the health of a stream. A brief video is shown to introduce students to real world problems faced by those who monitor stream quality.	• Explain that water in the stream is much different than water that falls as precipitation • State the parameters used to assess water quality • Describe water sampling protocols	**ESS2.C** **MS-LS2-3**	1. "From the sky to the ground" Introductory Powerpoint 2. "Student Demonstration on Water Quality" Sheet
Lesson 2: pHundamentals of Acids and Bases Students will be given an in depth definition of pH both as defined by the pH scale and by the existence of Hydrogen ions. A lab activity accompanies the lecture where students will dilute common household	• Define an acid and a base with respect to the pH scale • Define an acid and a base with respect to Hydrogen ion concentration • Understand the pH scale is logarithmic and that a 1 point increase/decrease results in a 10 fold change • Determine whether a solution is	**ESS2.C** **MS-LS2-3**	1. "pHundamentals of Acids and Bases" Introductory Powerpoint 2. (pH)undamentals of Acids and Bases Activity Sheet 3. (pH)undamentals of Acids and Bases Notesheet

items with water and measure the resulting pH. Assessment of student knowledge will be given in the form of questions at the end of the lab.	acidic or basic by using pH test kits (Litmus paper) ● Show, through graphing, how the pH of an acid or base changes by dilution with water		

Lesson 3: How do you DO? Students will be given a brief lecture on what dissolved oxygen is and how it gets into streams. The introductory lecture is followed by a lab activity that has students graph the relationship between temperature and dissolved oxygen. Assessment of student knowledge will be given in the form of questions at the end of the lab.	• Define what dissolved oxygen is • Explain how dissolved oxygen gets into the water • Illustrate, graphically, the relationship between DO and temperature • Explain how the amount of DO affects different aquatic life	**ESS2.C** **MS-LS2-3**	1. "How do *you* DO?" Introductory Powerpoint 2. "How do *you* DO?" Activity Sheet 3. Pens/Pencils
Lesson 4: Specific Conductivity A brief demonstration to engage students will be given where 3 solutions are used to illustrate how conductivity is controlled by the amount of ions in solution. The introductory lecture defines specific conductivity and goes over the definition of an ion. A lab activity is then carried out by the students where	• To define specific conductivity • To define an ion • To understand that ions contribute to the conductivity of a solution • To define a <u>weak</u> and <u>strong</u> electrolyte	**ESS2.C** **MS-LS2-3**	1. "Specific Conductivity and Ions" Powerpoint 2. "Specific Conductivity Lab" Sheet 3. "Specific Conductivity Demonstration" Sheet 4. Pencil 5. Calculator

they increasingly add more salt to a beaker of distilled water and measure the specific conductivity change using multimeters. The concentration vs specific conductivity is graphed. Assessment of student knowledge will be given in the form of questions at the end of the lab.			
Lesson 5: Mackin with Macro(Invertebrates) The lesson opens with preserved macroinvertebrates being passed around the room. The introductory lecture continues with the definition of a macroinvertebrate, and how they are used to measure stream quality. A laboratory with the students involves 4 packets with different macroinvertebrate populations. The students have to identify the macroinvertebrates based on physical characteristics,	• Define macroinvertebrates • Explain how macroinvertebrates are used to assess stream health • Demonstrate knowledge of how macroinvertebrates assess stream health through an activity that has students determine the health of a stream by analyzing the macroinvertebrates found in 4 different streams and then determining overall stream health • Define macroinvertebrate tolerance with respect to different water quality ranges of pH, Dissolved Oxygen and temperature	**ESS2.C** **MS-LS2-1** **MS-LS2-3** **MS-LS2-4**	1. "Mackin with Macroinvertebrates" PowerPoint 2. Macroinvertebrate Packets 3. Macroinvertebrate Samples 4. Pens/Pencils

and then group them into pollution groups to assess each streams health.			
Lesson 6: Field Trip The field trip (tailored for a school in L'Anse, MI) has students sampling the parameters that were discussed in the unit at 2 different streams. Students are asked to come up with a presentation on the differences in stream chemistry for the final project.	• Students will venture into the field in 2 nearby streams around the school and measure water quality parameters previously discussed in the previous lessons • Students will prepare a poster on their findings to present to the class at a later date comparing the difference in chemistry of the two streams	**ESS2.C** **MS-LS2-1** **MS-LS2-3** **MS-LS2-4**	1. Field Guide Handout 2. Pencils 3. Multimeters/Water Quality monitoring equipment 4. Macroinvertebrate nets 5. (Optional) Presentation Guidelines for poster on what the students found

Safety Considerations:

Students who may have allergies need to be considered when travelling on field trips

Students will need proper gear for walking close to a stream outdoors and for unpredictable weather conditions.

For Lesson 2, some chemicals used in the lab exercise are irritants, though caution is taken to dilute as much as possible. Goggles and gloves will be required.

Evaluation Plan:

The evaluation of student knowledge will be conducted through a field trip that has them measuring all the parameters that were detailed in their previous labs. The end product is a detailed analysis of two rivers in their nearby watershed. This analysis will be presented in the form of a presentation on the chemistry of the two rivers with reasons why there may be differences.

Resources (websites):

pH Simulator:

https://phet.colorado.edu/en/simulations/category/new

Resource on water quality sampling:

http://thewaterproject.org/resources/

Macroinvertebrate collection techniques (USGS):

http://infotrek.er.usgs.gov/doc/wdnr_biology/archives/Macroinvproto.pdf

Macroinvertebrate Samples:

http://www.lcnrcd.com/educator-resources

Brief description of how this unit relates to your graduate research. (1 page):

Water chemistry measurements are an important part of defining stream health with regards to ecosystem vitality and sustainability, as well as providing insight into in stream process that may affect overall stream quality. Measuring specified water quality parameters in a stream can also provide a holistic view of watershed properties and processes. My interest in water quality deals with the latter application, as I am currently in the process of writing a proposal to use water quality measurements to define watershed process and character for use in flood frequency analysis. This includes using Reference Watersheds categorized by the United States Geological Survey (USGS) as a baseline to relate specific watershed process and characteristics to measured water quality parameters. These parameters can then be used to group sites according to similar watershed drainage and geology as a proxy for process controls on flood generation, thereby providing a simple

method to group different sites for flood prediction. Therefore, this unit provides a learning experience for me as well as a medium to demonstrate to students how these parameters are measured and used in hydrological applications.

Water quality sampling requires a fundamental understanding of basic chemistry, and a presence in the field that can provide for a great learning environment. I chose to do a unit on this subject because it can provide an applicable environment to chemistry concepts that are a necessary part of the core 8th grade curriculum, as well as expand student experience to a field activity that allows them to use the skills learned in the classroom in a real world setting.