Water Quality in the Columbia River Watershed

Mrs. Debra Berg's Columbia Middle School Students
Fort Spokane. 2009 Photo taken by Tonilee Hanson

A 6th - 12th Grade Environmental Science Unit

Place is important! How does geographic and geologic information help us understand the current conditions of the Columbia River Watershed? Consider your river or lake study location and the nearby area. How have your study location, the Upper Columbia River or Lake Roosevelt changed in the past 5 years? What changes occurred as a result of building Grand Coulee Dam? What can changes over the past 500 years tell us about possible future changes to this place we call "our home"? How do local water quality conditions compare to global water quality conditions?

Protocols are important! Water quality testing, analyzing and interpreting the results are the primary focus of this unit. Systematic sampling methodology and consistent procedures are vital for reliability of data. Water quality testing is a critical part of gauging the ecological health of the Columbia River Watershed and Lake Roosevelt. Water quality data can show evidence of past or current human impact, ecological needs, and stewardship activities within the Columbia River Watershed's complex ecosystem.

Thinking, reflecting and scientific inquiry are important! Understanding the Columbia River Watershed is so much more than just knowing historical, geographical, physical, chemical and biological conditions. Understanding requires asking your own questions, considering complex interrelationships within watersheds, between atmospheric conditions, the shoreline and water bodies, the presence of native, domesticated and invasive species, and human impacts over time. Understanding results from developing inquiry questions, conducting research, and implementing stewardship projects that attempt to answer questions and solve problems that are **important to you!**

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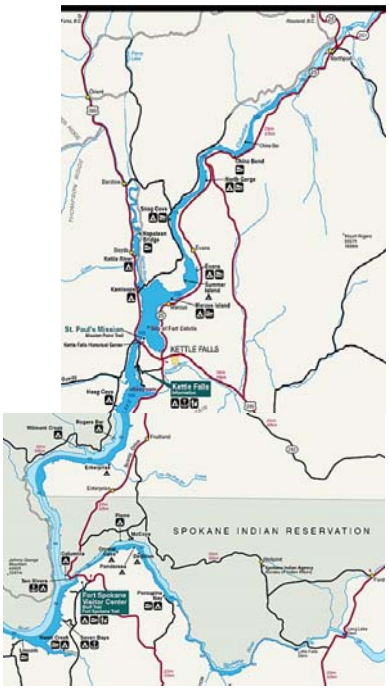

Preface and Acknowledgements

Water Quality in the Upper Columbia River & Lake Roosevelt is designed such that students apply science content knowledge and inquiry, investigation and problem solving skills within the context of community service and stewardship. Students are empowered to think and take actions as members of a community that lives, works, and recreates near the Upper Columbia River & Lake Roosevelt. Students learn to collect and analyze water quality data and consider the interrelationships between human activities, changing watershed conditions and lake water quality.

This unit strategically builds upon the exemplary lesson plans, protocols, and resources created by programs such as Floating Classroom, Project Wet, Project Wild, Nature Mapping, and multiple internet resources. Washington State Department of Ecology (ECY) and the Environmental Protection Agency EPA web resources were used for validated data. These exemplary programs and resources serve as a foundation for launching Lake Roosevelt based student inquiry and investigation. Every attempt was made to gratefully acknowledge and cite the contributions of others who have developed the tools which this unit will use in support of teachers and students implementing “The River Mile” (TRM) a program of the National Park Service Program.

See citations (page 23) for complete list of resources used in this unit

UNIT AT A GLANCE

Grade levels: 6 - 12

Content Area: Science
Environmental
Physics
Chemistry
Biology

Suggested Timeframe:
3 weeks / Options
Each lesson can stand alone.

Lesson sequence can be reorganized.

Supplemental lessons are provided that could extend the time frame for this unit.

EALRS Addressed:
- 2 Inquiry
- 3 Application

Washington State Content Standards:
- PS2 -2A, 2B, 2C, 2D, 2E
- PS3- 3B, 3C, 3E
- ES2-2A, 2B,2C, (review)
- ES2-2D, 2G
- LS1-1F
- LS2-2A, 2D, 2E
- LS3-3E,3F

http://www.k12.wa.us/CurriculumInstruct/default.aspx

UNIT OVERVIEW
Water Quality in the Upper Columbia & Lake Roosevelt

UNIT DESCRIPTION

Water Quality in the Upper Columbia River & Lake Roosevelt asks students to apply knowledge from chemistry, physics, geology, and biology and think about factors that impact water quality. Students use systematic protocols to collect, present, analyze and interpret water quality data. In collaborative groups, students consider implications from the data to identify interrelationships between human activities, changing conditions and water quality.
This unit invites students to reflect on their learning, plan a local stewardship project and take action as members of a community that lives, works, and recreates near the Upper Columbia River and Lake Roosevelt.

ENDURING UNDERSTANDINGS:
- Water quality results from complex interactions between biological, chemical, physical and environmental factors.
- Data is a powerful tool for explaining the world and communicating with others about world conditions.
- Actions have intended results and unforeseen consequences.

ESSENTIAL QUESTIONS:
- How is water quality affected by interactions in a watershed?
- How do we simultaneously use and protect our water and watershed?
- What leadership can I bring to my community?

STANDARDS ADDRESSED:
- Physical Science: Matter Properties and Change (PS2)
- Physical Science: Energy Transfer Transformation & Conservation (PS3)
- Earth & Space: Earth Systems, Structures, & Processes (ES2)
- Life Science: Structure & Function of Organisms (LS1)
- Life Science: Ecosystems (LS2)
- Life Science: Biological Evolution – Variation & Adaptation (LS3)

UNIT AT A GLANCE

Assessment Summary:

Pre-Assessment
Lesson 1: Water Quality Prior Knowledge

Formative Assessment
Lesson 2: Design a Water Filter

Formative Assessment
Lesson 10: Water Footprint - Data Collection, Analysis & Personal Action

Summative Assessment: Task:
Lesson 11: Watershed Research, Investigation, and Presentation

Application of Content understanding:

Lesson 12: The River Mile Academic Excursion/ Site Visit

UNIT OVERVIEW continued

Water Quality in the Upper Columbia & Lake Roosevelt

ASSESSMENT OVERVIEW:

This unit is designed to develop the scientific inquiry skills of asking a researchable question, literature research, data collection, presentation, analysis, interpretation and drawing conclusions and real world application. The scientific inquiry skills are developed in relationship to watershed content knowledge, understanding water quality and water quantity issues, and placed in the local context of the Columbia River /Lake Roosevelt. Students are given multiple opportunities within this unit to apply the inquiry/investigation skills. The unit culminates with an academic excursion (site-visit) to a River Mile location where water quality data is collected.

Each lesson is designed to develop a specific aspect of the scientific inquiry & investigation process and specific water quality content.

- Lesson 1: Pre assessment: What determines water quality?
- Lesson 2: Experimental design/water filter/fecal coliform
- Lesson 3: Writing factual observations/erosion/turbidity
- Lesson 4: Data Comparison & graphic presentation/pH
- Lesson 5: Data tables/temperature/species survival
- Lesson 6: Data analysis/nitrogen/phosphorus/ dissolved oxygen
- Lesson 7: Variables/water transport/point & non-point pollution
- Lesson 8: Interpretation & conclusion/bioaccumulation & survival
- Lesson 9: Communicating ideas/climate change/Socratic Seminar
- Lesson 10: Using data to inform personal action/water footprint
- Lesson 11: WQ literature review, scientific research/presentation
- Lesson 12: Application/TRM site visit/water quality

UNIT AT A GLANCE
Skills: Design an investigation Test variables Collect data Analyze data Draw conclusions Present findings **Content/concepts:** Clean water is essential to the survival of life.

UNIT OVERVIEW continued
Water Quality in the Upper Columbia & Lake Roosevelt

KNOW/DO/UNDERSTAND

Students are introduced to the global & local water quality & quantity issues. They discover water quality parameters and use testing protocols. Students collect, analyze and interpret data from classroom, field and validated sources. Students choose a local water issue to research and develop a community stewardship project to impact water quality.

MODIFICATIONS FOR DIFFERENTIATING INSTRUCTION IN THIS UNIT:

- Identify students specific learning strengths, needs, working styles and dominant intelligences for successful collaborative work
- Increase amount of vocabulary development by: encouraging the use of dictionaries (including bilingual), employing visuals and gestures, using music, role play, graphic organizers, and concept posters.
- Pair ELL with bilingual student
- Modifications for special needs such as extended time or read aloud
- Demo skills/ instructions or present outcome samples for guidance
- Chunk tasks

Upon completion of this unit, what students will **know,** be **able to do** and **understand**?

Know	Do	Understand
Water quality parameters and protocols for testing temperature, pH, dissolved oxygen, nitrogen (nitrates), phosphorus (phosphates), turbidity & conductivity. Water is a solvent. Substances in water can mix, suspend, dissolve and form compounds. Temperature changes the properties of water. Erosion & weathering of landforms introduces substance into the water.	Design & conduct an inquiry investigation & build a water filter. Use protocols to conduct water quality tests, lab investigations & field studies. Collect, analyze & interpret data. Use various resources (primary and secondary). Discuss/ debate a scientific issue in Socratic Seminar format. Present research using power point, video, or research report. Cite sources using APA style. Design & implement a community stewardship project.	Water quality is a function of the interrelated conditions and interactions among land, air, water and living organisms. Living organisms are dependent on water for survival. How human activity can negatively & positively impact the quantity & quality of water. Each person can demonstrate leadership and make a positive impact.

UNIT OVERVIEW continued

Time Frame/Planning Sketch

Week 1	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
Time	90 minutes	90 minutes	90 minutes	90 minutes	90 minutes
Introduction	Water Quality a Global & Local Issue	Water Quality: Fecal Coliform	Water Quality: Turbidity & Conductivity	Water Quality: pH and acid rain	Water Quality: Temperature
Assessment: Pre, Formative, Summative	(P) What determines water quality?	(F) Effective design & accurate data collection	(F) Writing factual, specific observations	(F) Selection of graph to display data	(F) Data presentation for interpretation
Inquiry/Literacy	Putting the Issue in context – Initiating Inquiry Questions	Design & conduct experiment, collect data, multiple trials	Observational data	Data table, comparison bar, line or scatter graph	Data Collection and analysis
Investigation	Culminating Project Research project	Design & test a Water Filter	Van Cleave Erosion Stations: 43, 45, 46, 50 GLOBE Transparency & Conductivity Labs	Optional GLOBE pH Lab	Optional GLOBE Temperature Protocol and Lab
Activities	Video "Water for Life" Article: "Waste on Lake Roosevelt Shores" Discussion	Test sample of polluted water, filter & retest. Document Δ, record data Teach classmates to use your filtration process	Show WQ Overview PP Erosion & deposition, changing lake levels, & draw down	Test wide range of pH samples Discuss Acid Rain Grand Coulee & Hawk Creek data analysis	Discuss WQ parameters & species survival by degree C
Take Action	Ask questions that lead to research & investigation	(O) No pet waste or Fences for livestock campaign	Riparian zone replanting	No idle zone -bike to work & school -reduce auto emissions	Tree planting & riparian vegetation restoration
Materials	Article, journal YouTube	Funnel, cheesecloth, sand, gravel, etc.	TRM Water Sample RS	TRM Water Sample RS	TRM Water Sample RS TRM Core Parameters RS
Google Earth Mapping	(O) Water Aid Google map	Hawk Creek	Locate dams on the Columbia River	Acid rain impact	Climate Change map NOAA - trends
Resource Specialists	LRF, NPS, LARO	Dept of Ecology	Spokane Tribe of Indians Fisheries	Spokane Regional Clean Air Agency	Lands Council Kat Hall
Optional (O) Homework (HW)	(O) Water Carrying activity (HW) How can water be purified?	(HW) Refine your filter design, sketch & write instructions for use	(O) Research landslide 2009 Porcupine Bay	(HW) Test pH of home cleaning products and cosmetics and their impact on water	(O) Tree Canopy, temp & WQ Hydropower & changes in precipitation

Week 2	Lesson 6	Lesson 7	Lesson 8	Lesson 9	Lesson 10
Time	90 minutes	90 minutes	90 minutes	90 minutes	90 minutes
Introduction	Nutrient loading phosphorus, nitrogen & dissolved oxygen	Point source & non-point source pollution	Bioaccumulation and Biomagnification	Climate Change Precipitation	Water Use and Conservation Awareness
Assessment	Data analysis from Ecology reports	Variables: controlled, dependent independent	Draw Conclusions	Data Analysis Fact vs. opinion	Water Footprint Collect Statistical Data
Inquiry Literacy	Fish survival & DO!	Where is it coming from?	Who will survive?	What do you mean, "We might run out of water?"	How much water does my family use?
Investigation	Phosphorous, Nitrogen & DO Lab	Don't Dump that here! Watershed & Toxic dump	You ate what? - Simulation Game	Socratic Seminar Discussion	Home Water Audit
Activities	Ph Ni & DO lab Compare the interrelationship between nutrient levels, dissolved oxygen levels, temperature and fish survival	Students use a simple watershed model to observe the storm water transport of PS & NPS pollution. Students use points, plots & transects to record observation.	How do the benthic organisms & aquatic plants determine which other organisms survive?	View You Tube Video Clips Of climate change proponents & skeptics Engage in Socratic Seminar Analysis of the climate change data and rebuttal.	Students identify the many ways we use water daily in all we do and all we consume. Student calculates their weekly water use and its cost compared to gasoline.
Google Earth Mapping	Ecology Test WQ test sites at North Port, Kettle River, Hawk Creek & Grand Coulee	EPA Scorecard on PS polluters and animal waste by county	Tracing the potential contaminant path from Trail BC Canada to large mouth bass I just caught	NOAA Climate change indicators NASA global precipitation changes	What path did this water take to get into my home?
Take Action	Public Awareness Campaign: Storm water runoff	What are best management practices to reduce pollution?	Fish Health Advisory Awareness campaign	General public interviews & surveys	Develop plan to reduce household water use by 3-5%, implement, analyze
Materials	TRM Water Sample RS Ecology TMDL data	You Tube Videos Exploratorium - Stream table set-up River cutters Toxic waste	LRF Public Guide	Socratic Seminar Protocol: Excerpts from pro & con climate change videos and EPA Climate change data	Water Use How Big Is My Water Footprint? Student Guide
Optional (O) Homework (HW)	HW Research Report Benchmark	HW Research Report Benchmark	HW Research Report Benchmark	HW Research Report Benchmark	Interview family members RE: behavior changes for conservation

Week 3	Lesson 11		Lesson 12
Time	Intro Day 1 – 2 WK as Homework	2 Day for Presentations or as needed	1 Day Field Trip
Introduction	Culminating Project Water/Watershed Investigation & Research	Student Presentations of Water Research Project	Academic Excursion to The River Mile site
Assessment	Presentation Written, PP, Oral, Video Rubric for content & presentation	Presentation Written, PP, Oral, Video	Student Journal w/ land & water observations and water quality sampling numeric data
Inquiry Research	Communication	Asking new questions based on research findings	Apply WQ testing processes and knowledge to an Inquiry Field Investigation of The River Mile site
Investigation	List of possible investigations provided but students have choice to develop a unique study	Discuss the method of investigation	Conduct field tests that were practiced in labs. What do the conditions at this site reveal about interactions among the population species, land, air & water?
Activities	Research compare & contrast local & global WQ issue	Student use a rubric to peer evaluate presentations	Observation of land water interface, animal and plant populations and water quality testing
Google Earth Mapping	Include a Google map	Show a map of a local and global area impacted by research	Map of The River Mile site or alternate field study location
Take Action	Community Service/ Stewardship as part of research	Students discuss actions they have or will take that would positively impact the community	Students earn their seat on a trip by completing research on a chosen topic before the trip
Materials	Research project packet Internet access Assessment rubric	Peer Evaluation Rubrics	Field guides water quality testing protocol personal science journal
Optional (O) Homework (HW)	Students are given benchmarks to meet during the 2 week preparation	Reflective journal on personal presentation and learning from classmate presentations	Compare field study data to lab testing data to assess the water quality at your field site.