Project-Based Inquiry Science: Living Together
Storyline

Targeted PEs:
· MS-LS2-1 · MS-LS2-2 · MS-LS2-3 · MS-LS2-4 · MS-ESS3-3 · MS-ESS3-4 · MS-ETS1-1

Living Together: What's the Big Question?
How Does Water Quality Affect the Ecology of a Community?

Storyline (with Disciplinary Core Ideas and Science Content)	**Science and Engineering Practices**	**Crosscutting Concepts**
In the introduction to *Living Together,* students are introduced to the *Big Question: How does water quality affect the ecology of a community?* Students begin the unit with two immersion experiences meant to elicit their initial thinking about the *Big Question*. First, students make claims about the quality of five jars containing different water samples collected along a river. Students continue to think about water quality and what environmental factors affect water quality as they make observations of photos, taken at different locations along a river, and match them to the jars of water, explaining their reasoning. Based on these experiences, students identify things they already know and questions they have about water quality that will help them answer the *Big Question*. To help guide students in answering the *Big Question*, they are introduced to the *Big Challenge* of the unit, which is to determine how the towns of Wamego and St. George, located on the Crystal River, might survive ecologically, culturally, and economically if a new manufacturing company were to move to Wamego. After discussing the *Big Challenge*, the unit *Introduction* concludes with the class creating the *Project Board*.	**Analyzing and Interpreting Data** (students analyze & interpret observational data of water jars and photos) **Engaging in Argument from Evidence** (students provide evidence-based reasoning for matching photos to water samples) **Asking Questions** (students develop questions they will need to answer throughout the unit related to water quality)	Unit Level: **Cause and Effect** (students begin to think about environmental factors that impact water quality)

Living Together: Learning Set 1
How Do Flowing Water and Land Interact in a Community?

Storyline (with Disciplinary Core Ideas and Science Content)	**Science and Engineering Practices**	**Crosscutting Concepts**
Introduction to *Learning Set 1* and *Section 1.1*: In this *Learning Set*, students figure out the interconnectedness of land and water in a community. Students begin to think about water and land by discussing what they already think they know about their local water system. Based on this discussion, students update their *Project Board*.	**Asking Questions** (students develop questions they will need to answer throughout the unit related to water quality)	Unit Level: **Cause and Effect** (students begin to think about the relationship between land and the water that flows through it) Section Level: **Systems and System Models** (students model water flow in a watershed) **Patterns** (students observe patterns in water flow and pooling)

Section 1.2: In this section, students build a model, which they use to simulate how water flows on land. Students use their model to make predictions and explain how water flows from higher to lower elevations. **Disciplinary Core Ideas:** **ETS1.A: Defining and Delimiting Engineering Problems** · The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)	**Developing and Using Models** (students develop and use a physical watershed model; students also draw and use a 2D version of this model) **Analyzing and Interpreting Data** (students analyze observational data of water flow in their model) **Engaging in Argument from Evidence** (students engage in discussion as they share their model results and explanations with their class) **Obtaining, Evaluating, and Communicating Information** (students communicate the results of their model in an *Investigation Expo*)	Unit Level: **Cause and Effect** (students begin to think about the relationship between land and the water that flows through it) Section Level: **Systems and System Models** (students model water flow in a watershed) **Patterns** (students observe patterns in water flow and pooling)
Section 1.3: In the previous section students used a model to gain evidence that water moves from higher to lower elevations, providing them with some initial experience with the concept of a watershed. In this section they are introduced to the term "watershed." As their teacher guides them through a reading, students think about how water moves through a watershed.	**Obtaining, Evaluating, and Communicating Information** (reading about how water moves in a watershed)	Section Level: **Systems and System Models** (students make connections between reading and model of water flow in a watershed)
Section 1.4: In this section students apply what they have been learning in the previous two sections about how water flows in watersheds to a new context. They use 2- and 3-dimensional maps of Michigan to trace the movement of water within a small watershed of their own choosing. They continue to apply what they have learned about the relationship of land elevation and water to trace water movement through Michigan to the Great Lakes.	**Developing and Using Models** (students use 2-D and 3-D maps to explain water movement) **Obtaining, Evaluating, and Communicating Information** (using maps; reading on nested watersheds)	Section Level: **Systems and System Models** (students use 2-D and raised relief maps to explain water movement in the U.S.) **Patterns** (students observe patterns in land that determine water flow)

Section 1.5: Students are introduced now to a specific watershed, the Rouge River watershed, which they will use as a model to study how the water quality in a river affects the ecology of the river and its watershed, which will help them understand Crystal River and how to address the *Big Challenge*. In this section the teacher guides students through a reading in which they learn about the location and history of the Rouge River watershed, and how it is a part of a bigger water system. Students consider the many ways in which humans use the Rouge River, and how changes in the water quality of the river brought about by human activity affect people living in the watershed. Using their own experiences, their model from the previous section, as well as the Rouge River reading, students begin to make connections and apply their knowledge to the *Big Challenge*. Students discuss the four land uses (residential, commercial, industrial, and agricultural), and brainstorm different ways in which these different land uses change the land, and how these changes might affect Crystal River and Wamego. They will use this information in future sections when they discuss changes in water quality brought about by the different ways in which humans use the land. **Disciplinary Core Ideas:** **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)	**Obtaining, Evaluating, and Communicating Information** (reading on the Rouge River)	Unit Level: **Cause and Effect** (students begin to consider how human land use affects the land and water quality) **Stability and Change** (humans changing the land) Section Level: **Patterns** (students consider patterns in how humans use land)
Section 1.6: Now that students have discussed the four types of land use, and the ways in which these uses change the land, each group will plan, construct, and then use a model of a specific type of land use to make predictions about how flowing water will affect the land use, and how the land use will affect water that flows through it. Groups test their model and share their data with other groups so that all students have access to the data for other land uses, and they can compare how each kind of land use affects water in the watershed. Students also use their model to explain how different variables they identified in their models might affect 1) the amount of deposition in the river, and 2) the amount of erosion in the river. **Disciplinary Core Ideas:** **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)	**Developing and Using Models** (students construct and use models of different land use to determine how water affects land and vice-versa) **Planning and Carrying Out Investigations** (students use a model to investigation the relationship between land and water flowing through it) **Analyzing and Interpreting Data** (students analyze and interpret the results from running their models) **Constructing Explanations** (students explain the deposition in a river and erosion around a river) **Obtaining, Evaluating, and Communicating Information** (students communicate the results of their model in an *Investigation Expo* so that the class may have a complete data set)	Unit Level: **Cause and Effect** (how land use affects water and vice-versa) **Stability and Change** (humans changing the land in different ways) Section Level: **Systems and System Models** (modeling water flow through a type of land use) **Patterns** (patterns in water movement as a result of land use)

Section 1.7: In the previous section students used models of different land uses to explore how moving water can pick up soil (erosion) in one place and drop or deposit (deposition) it elsewhere as the water slows down. In this section, the teacher guides students through short readings and examination of drawn models of different land use to examine the types of human activities that occur in different land uses and how they can affect water quality. Students apply terms they have been introduced to in previous learning sets (erosion, deposition, runoff, and groundwater) as they discuss the land use impacts on water quality. **Disciplinary Core Ideas:** **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)	**Obtaining, Evaluating, and Communicating Information** (reading about different types of land use; update the *Project Board*)	Unit Level: **Cause and Effect** (how land use affects water quality and vice-versa) **Stability and Change** (humans changing the land in different ways) Section Level: **Systems and System Models** (pictures modeling water flow through a type of land use) **Patterns** (patterns in water movement as a result of land use)
Section 1.8: Students examine some different sources of pollution in a river by first developing some common language by identifying what pollution is, and what substances can be characterized as pollution. Students apply what they have been learning about the relationship between land use and water quality to first individually then as a group to examine pictures showing multiple land uses simultaneously. This activity prepares students to classify pollution into two types: point-source and non-point-source pollution. Students then read about these two classifications of pollution. Using what they learn in these readings, students revisit pictures of different land uses from the beginning of the unit and identify the sources of pollution in the pictures, whether it is point-source or non-point-source, and provide evidence for their choices. Using information they have collected from their investigations, models, readings, and class discussions, students make evidence-based claims about the relationship between land use and water quality, which they use to update the *Project Board*. **Disciplinary Core Ideas:** **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)	**Obtaining, Evaluating, and Communicating Information** (reading on sources of pollution)	Unit Level: **Cause and Effect** (how human activity in different types of land use results in pollution that may end up in a river) **Stability and Change** (humans changing the land in different ways)

Back to the Big Question: Throughout this learning set students have been exploring the relationship between water and land, specifically, how water affects the land, and how land use affects the water as it moves through a community. Using information and evidence from their investigations on how water flows through a watershed and how specific types of land use can affect water resources, students provide initial answers to the *Big Question* and make initial recommendations to the Wamego town council. Their recommendations consist of evidence-based claims and science knowledge. The recommendations are shared, discussed, and revised as necessary. The *Project Board* is updated with their recommendations. **Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Constructing Explanations** (students make evidence-based recommendations to the town council of Wamego) **Obtaining, Evaluating, and Communicating Information** (students share their explanations and update the Project Board)	Unit Level: **Cause and Effect** (how land use affects water quality and vice-versa) **Stability and Change** (humans changing the land in different ways) Section Level: **Patterns** (patterns in water movement as a result of land use)

Living Together: Learning Set 2
How Do You Determine the Quality of Water in a Community?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices	Crosscutting Concepts
Introduction to *Learing Set 2* and *Section 2.1*: Students are introduced to a new guiding question in this *Learning Set*. Given that they have already learned about the different ways that land use can impact water quality, in this *Learning Set* they focus on how the water quality can be judged. Students begin to explore this new question by first sharing their own experiences and ideas about water quality with their classmates. To help ground the discussion of their own ideas about water quality, students must decide whether they agree or disagree (and provide reasoning) with the ideas of four students identified in their book. This discussion supports students in identifying more things they will need to investigate. Based on this, the class updates the *Project Board*.	**Asking Questions** (students develop more questions they will need to answer throughout the unit related to the *Big Question*)	Unit Level: **Patterns** (patterns in indicators of water quality)
Section 2.2: In *Learning Set 1* students began to think about point and non-point pollution sources that can affect water quality in a watershed. In this section students investigate fertilizer as a possible pollution source that can runoff into rivers and impact the growth of plants in and around the river. Students plan and conduct an experiment to determine the relationship between fertilizer concentration and plant growth. This experiment supports students in learning that plant growth can be an indicator of the amount of commonly used substances, such as fertilizers, in water. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	**Planning and Carrying Out Investigations** (students design and conduct an experiment to determine the relationship between fertilizer and plant growth) **Analyzing and Interpreting Data** (students analyze and interpret the results of their experiment) **Obtaining, Evaluating, and Communicating Information** (students share their experimental plan with the class to receive feedback and decide on a class plan) **Using Mathematics and Computational Thinking** (students look for relationships in data)	Unit Level: **Cause and Effect** (how different factors affect water quality) **Stability and Change** (humans changing the land, and water, in different ways) Section Level: **Patterns** (patterns in indicators of water quality)

Section 2.3: In the last section, students learned about plant growth as an indicator of water quality. In this section, students learn about another indicator of water quality: pH. Students observe a demonstration of three jars of clear liquid - distilled water, and jars 3 and 4 from the beginning of the unit – and, using a cabbage juice indicator, begin to think about the relationship between pH and water quality. This positions them to engage in a reading and discussion about pH and acidity, which they connect back to the larger discussion about indicators of water quality. Students then measure the pH of unknown liquids, which they compare to the jars from the beginning of the unit. They also mix solutions to see what happens to the acidity of the solution. After reading a little more about pH and basicity, students discuss how pH is an indicator of water quality. Specifically, they make predictions about the impact changes in water pH might have on various organisms. Students use the information and data collected in this section to consider how they would advise Wamego how the acidity of water in the Crystal River might affect trout populations and their annual Trout Festival. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	**Planning and Carrying Out Investigations** (students conduct an experiment to determine the relationship between pH and water quality) **Analyzing and Interpreting Data** (students analyze and interpret the results of their investigations) **Obtaining, Evaluating, and Communicating Information** (readings on pH, acidity, basicity) **Using Mathematics and Computational Thinking** (students look for relationships in data)	Unit Level: **Cause and Effect** (how different factors affect water quality) **Stability and Change** (humans changing the land, and water, in different ways) Section Level: **Patterns** (patterns in indicators of water quality)
Section 2.4: In this section, students learn about another indicator of water quality: dissolved oxygen. While the teacher uses probes to demonstrate the effects of temperature and turbulence on the amount of dissolved oxygen in water, students make observations and collect data. They then analyze their data for trends and engage in a reading and discussion about how the amount of dissolved oxygen is an indicator of water quality, and how it might affect living things in a river, in particular, how it might affect the trout in Crystal Lake. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	**Planning and Carrying Out Investigations** (students observe an investigation to determine the relationship between temperature and dissolved oxygen, and turbulence and dissolved oxygen) **Analyzing and Interpreting Data** (students analyze data for trends and interpret the results of their investigations) **Obtaining, Evaluating, and Communicating Information** (reading on dissolved oxygen) **Using Mathematics and Computational Thinking** (students look for relationships in data)	Unit Level: **Cause and Effect** (how different factors affect water quality) **Stability and Change** (humans changing the land, and water, in different ways) Section Level: **Patterns** (patterns in indicators of water quality)

Section 2.5: In this section, the teacher guides students through reading and thinking about the influence of other indicators (thermal pollution, turbidity, and fecal coliform) on water quality. Students think about these other indicators in relation to the big challenge. Students are also challenged to consider "chains of events" that result in impacts to water quality (e.g., industry moves in next to a river, uses the water to cool down parts; returns warmer water to the river; impacts dissolved oxygen content; which impacts plant and animal life). The information in this section adds to science knowledge that students can use when they diagnose possible water-quality problems that might be faced by the town of Wamego if its community and its ecology are changed. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4)	**Obtaining, Evaluating, and Communicating Information** (reading on other indicators of water quality)	Unit Level: **Cause and Effect** (how different factors affect water quality; chains of cause and effect) **Stability and Change** (humans changing the land, and water, in different ways) Section Level: **Patterns** (patterns in indicators of water quality)
Back to the Big Question: By exploring several different indicators of water quality in this learning set, students have a better sense of how water quality in a watershed can be determined. In this section students apply what they have been learning about water quality indicators to the land use that they explored in *Learning Set 1*. Specifically, student groups must examine the photos of their assigned land use from *Learning Set 1* and provide evidence-based explanations for what water quality tests they think should be conducted. After sharing their ideas with the class, students update the *Project Board* with their recommendations about using water quality tests to determine water quality. **Disciplinary Core Ideas:** **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4) **ETS1.B: Developing Possible Solutions** · A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) · Models of all kinds are important for testing solutions. (MS-ETS1-4)	**Constructing Explanations** (students use evidence to explain their choice of tests to perform for their land use) **Obtaining, Evaluating, and Communicating Information** (students share ideas in an *Idea Briefing*; update the *Project Board*)	Unit Level: **Cause and Effect** (how different factors affect water quality; chains of cause and effect) Section Level: **Stability and Change** (humans changing the land, and water, in different ways) **Patterns** (patterns in indicators of water quality)

Living Together: Learning Set 3
How Can Changes in Water Quality Affect the Living Things in an Ecosytem?

Storyline (with Disciplinary Core Ideas and Science Content)	**Science and Engineering Practices**	**Crosscutting Concepts**
Introduction to *Learning Set 3* and *Section 3.1*: In *Learning Sets 1* and *2*, students focused on water movement in watersheds, different sources of pollution that can affect water quality, and different ways in which the land can be impacted by the water, and vice-versa. In *Learning Set 3*, students focus more on the interactions, specifically of living things, within an ecosystem. Students begin to think about interactions in ecosystems by discussing their own interactions with living (biotic) and nonliving (abiotic) things in various ecosystems in their lives. Students begin also to use terms such as "biotic," "abiotic," and "habitat" as they begin to think about organisms living together and interacting in a "community." They discuss different types of habitats, and update the *Project Board* with things they know and want to investigate related to aquatic organisms and habitats and interactions, which will help them address the *Big Challenge* and answer the *Big Question*. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	**Asking Questions** (students develop more questions they will need to answer throughout the unit related to the *Big Challenge*)	Unit Level: **Stability and Change** (changes in habitats and ecosystems) Section Level: **Systems and System Models** (thinking about interactions in ecosystems) **Patterns** (relationships between living and nonliving things in an ecosystem)
Section 3.2: At the beginning of this section, students think more about aquatic ecosystems by discussing the diversity and abundance of aquatic organisms with which they are already familiar. Students make observations of a video which shows scientists collecting aquatic organisms from a river. These observations support students in learning about how scientists do their work, for instance, the tools they used to collect aquatic organisms. Students engage in a discussion about the video wherein they see that now that a sample has been collected, it needs to be sorted to see what variety of organisms are present (diversity), and how much (abundance) of each they have. This provides students with a reason to classify organisms, which the students do next. Students use a dichotomous key to classify pictures of organisms based on how they look, and identify their names. Students make claims (their classification decision) and provide evidence (physical characteristics) for those claims, all of which they share with their classmates. Engaging first in a classification activity positions students to then learn about why scientists classify living organisms, which they do through a brief reading about the common characteristics of living organisms (e.g., they are made up of cells) and the ways in which organisms are different, and thus how they are classified. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** · Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)	**Obtaining, Evaluating, and Communicating Information** (readings on aquatic ecosystems and classification; video of scientists doing their work) **Engaging in Argument from Evidence** (students share the reasoning behind their classification and naming of an organism)	Section Level: **Patterns** (classification of organisms)

Section 3.3: Using what they learned in the previous section about collecting and classifying organisms, students analyze macroinvertebrate data collected from three points along a river, to help the residents living around Marry Martans Lake determine why there is suddenly more algae growing in the Lake. Through their analysis, and using science knowledge from a reading, students consider how groups of organisms, like the different macroinvertebrates in this case study, can act as biotic indicators that reflect the health of the ecosystem. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** · Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) · Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5) **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)	**Analyzing and Interpreting Data** (students analyze and interpret macroinvertebrate data to share with Marry Martans community) **Using Mathematics and Computational Thinking** (students look for relationships in data) **Engaging in Argument from Evidence** (students discuss the farmers' claims, based on the evidence collected) **Obtaining, Evaluating, and Communicating Information** (reading on biotic indicators)	Unit Level: **Stability and Change** (changes in habitats and ecosystems) Section Level: **Systems and System Models** (thinking about interactions in ecosystems) **Patterns** (relationships between living and nonliving things in an ecosystem)

Section 3.4: In the previous section, students learned about one way in which living things (macroinvertebrates) can serve as an indicator of water quality in an ecosystem. In this section, students revisit the previously introduced concept of turbidity, and conduct an investigation to examine the relationship between turbidity and a plant's ability to photosynthesize (and thus serve as another possible indicator of water quality). Using the results of their investigation and science knowledge from a reading on photosynthesis, students explain how turbidity affects living organisms, which they will eventually use to help them make recommendations to the town council of Wamego. Using this information, the class updates the *Project Board*. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)	**Planning and Carrying Out Investigations** (students run investigations with light and aquatic plants) **Analyzing and Interpreting Data** (students analyze and interpret data to determine the relationship between turbidity and light and photosynthesis) **Constructing Explanations** (students explain what happened in their investigation) **Obtaining, Evaluating, and Communicating Information** (reading on photosynthesis; update the *Project Board*)	Unit Level: **Stability and Change** (changes in habitats and ecosystems) **Systems and System Models** (thinking about interactions in ecosystems) Section Level: **Patterns** (relationships between living and nonliving things in an ecosystem) **Energy and Matter** (students develop some knowledge about the "movement" of energy through the process of photosynthesis)
Section 3.5: Up to this point, students have been focusing on how various factors affect water quality, and in turn how water quality can affect the organisms living around the water. In this section, students explore how water quality can affect all living things in an ecosystem by examining a model called a food chain. They begin to make connections between organisms by tracing common meals back to their sources, and ultimately the Sun. As they read, students are formally introduced to the concept of a food chain as a model to show the movement of matter and energy in an ecosystem, as reflected in the interactions between living things. Using the food chains they made, students trace the flow of matter and energy from organism to organism, and they identify the feeding classifications (producers, consumers; herbivores, carnivores, and omnivores), and feeding relationships (predator-prey) present in their diagrams. **Disciplinary Core Ideas:** **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** · Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)	**Developing and Using Models** (students use food chains to represent interactions and energy & matter flow between living things) **Obtaining, Evaluating, and Communicating Information** (reading on food chains and feeding relationships; students communicate their food chains to their class)	Section Level: **Systems and System Models** (modeling interactions in ecosystems; using food chains to model interactions) **Patterns** (relationships between living things in an ecosystem) **Energy and Matter** (the flow of energy and matter between living things in an ecosystem)

Section 3.6: In this section, students use what they learned about food chains and feeding classifications and relationships, as they run a computer simulation to see how changes in one part of the food chain affects organisms in another part. Students begin by considering the food chain they will be modeling: grass, mice, and coyotes. After they identify each species' role and quantity in the food chain, students make predictions about the factors that might affect the populations of the different species in the food chain. Students use a given procedure to observe what happens during a simulation of a population model that reaches equilibrium for realistic initial settings of grass, mice, and coyotes in a community. Groups are then assigned one of six scenarios to simulate how populations change in a community when the conditions in the ecosystem change, reinforcing their understanding that populations in a community are connected through food chains. They predict what they think will happen, run their model, and analyze the results, which they share with their class so that all students have access to the results of each group's model. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) · Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2) **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)	**Developing and Using Models** (students use food chains to represent interactions and energy & matter flow between living things; students simulate interactions between species) **Analyzing and Interpreting Data** (students analyze and interpret the results of their simulations to understand interactions in food chains) **Using Mathematical and Computational Thinking** (students use their collected data to determine how populations changed over time) **Constructing Explanations** (students explain why the populations in their models changed) **Obtaining, Evaluating, and Communicating Information** (reading on population changes; students communicate their results so the class can have access to all data)	Unit Level: **Cause and Effect** (what happens in one part of the chain affects animals in another part) **Stability and Change** (changes in habitats and ecosystems) Section Level: **Systems and System Models** (modeling interactions in ecosystems) **Patterns** (relationships between living things in an ecosystem; patterns between food webs) **Energy and Matter** (the flow of energy and matter between living things in an ecosystem)

Section 3.7: In this section, students apply what they have been learning about food chains and the interactions among populations in a community to explore how organisms in a watershed ecosystem rely on one another. Pairs of students create food webs using cards of organisms found in a watershed ecosystem. They then work with other pairs to create a multidimensional food chain (food web) to show all of the connections between interacting organisms. Students read about the role of decomposers in the transfer of matter and energy in an ecosystem. Using evidence collected from their food chain and web models, their simulations, and other investigations in this *Learning Set*, as well as science knowledge from the readings, students update the *Project Board*, focusing on the interconnectedness of the biotic parts of an ecosystem. *More to Learn*: Students use science knowledge from a reading on Earth's biomes to predict what kinds of biomes there are in the U.S. Students draw on evidence from the reading when they present their ideas to the class. **Disciplinary Core Ideas:** **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** · Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)	**Developing and Using Models** (students use food chains & webs to represent interactions and energy & matter flow between living things) **Obtaining, Evaluating, and Communicating Information** (reading on decomposers and food webs; biomes; adaptations; students communicate ideas about their food webs with the class; update the *Project Board*)	Unit Level: **Cause and Effect** (what happens in one part of the chain affects animals in another part) **Stability and Change** (changes in habitats and ecosystems) Section Level: **Systems and System Models** (modeling interactions in ecosystems) **Patterns** (relationships between living things in an ecosystem) **Energy and Matter** (the flow of energy and matter between living things in an ecosystem)

Living Together: Answer the Big Question
How Does Water Quality Affect the Ecology of a Community?

Storyline (with Disciplinary Core Ideas and Science Content)	Science and Engineering Practices	Crosscutting Concepts
With evidence collected from many investigative experiences and science knowledge from many readings throughout the unit, the class returns to address the *Big Challenge* and answer the *Big Question*. Rather than making recommendations to the town council of Wamego based on their own thinking, groups are assigned to represent the interests of one of four people, each with different ideas about allowing FabCo to move into Wamego. Groups are then tasked with preparing and presenting evidence-based arguments to the town council for why they do or do not want the new factory. **Disciplinary Core Ideas:** **LS2.A: Interdependent Relationships in Ecosystems** · Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) · In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) · Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) · Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2) **ESS3.C: Human Impacts on Earth Systems** · Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) · Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)	**Obtaining, Evaluating, and Communicating Information** (students read about their person's position so that they can argue from that stance) **Constructing Explanations** (students develop recommendations for why their person does/does not want Fabco) **Engaging in Argument from Evidence** (students use evidence collected over the unit to represent different arguments for why/why not to allow Fabco)	Unit Level: **Cause and Effect** (what happens in one part of the chain affects animals in another part; how land use affects water quality and vice-versa) **Stability and Change** (changes in habitats and ecosystems) Section Level: **Systems and System Models** (modeling interactions in ecosystems) **Patterns** (relationships between living things in an ecosystem; patterns in water movement as a result of land use) **Energy and Matter** (the flow of energy and matter between living things in an ecosystem)