ACTIVITY 6

Claims and Evidence

COMPUTER SIMULATION

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ACTIVITY SUMMARY

Students use a computer simulation to gather evidence and evaluate claims about the water quality of Skipton's Lake Timtim. They use multiple lines of evidence to support or refute their claims. The class discusses how new evidence can lead to a re-evaluation and revision of ideas. Based on the evidence, students make a recommendation to Skipton's city council about whether to use Lake Timtim as a water source for Skipton.

KEY CONCEPTS & PROCESS SKILLS

1 Scientific knowledge and explanations are based on evidence and strengthened by multiple lines of relevant, accurate, and reliable evidence.

2 New scientific tools and techniques contribute to the advancement of science by providing new methods to gather and interpret data and can lead to new insights and questions. Technology can enhance the collection and analysis of data.

3 Various observations of a single phenomenon from human senses and scientific tools can be used to verify the accuracy of evidence.

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:
Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.
(Science and Engineering Practice: Engaging in Argument from Evidence)

CONCEPTUAL
TOOLS

MULTIPLE LINES
OF EVIDENCE

SENSES &
INSTRUMENTATION
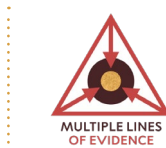
VOCABULARY DEVELOPMENT

claim
(assumed prior knowledge)
a statement that asserts something is true

MATERIALS & ADVANCE PREPARATION

FOR THE TEACHER
— VISUAL AID 6.1
  "Map of Skipton Area"

— VISUAL AID 6.2
  "Invention Timeline"

— VISUAL AID 6.3
  "Interpreting Graphs"
  (OPTIONAL)

— VISUAL AID 1.2
  "Scoring Guide: Evidence
   and Trade-Offs (E&T)"
  (OPTIONAL)

— ITEM-SPECIFIC
  SCORING GUIDE:
  Activity 6
  Build Understanding
  item 1

FOR THE CLASS
— COMPUTERS WITH
  INTERNET ACCESS

— ADDITIONAL MATERIALS
  (poster paper,
  markers, etc.) FOR
  CLASS PRESENTATIONS
  (OPTIONAL)

FOR EACH STUDENT
— STUDENT SHEET 6.1
  "Assessing My Evidence"

— STUDENT SHEET 6.2
  "Writing Frame:
   Claims, Evidence,
   and Reasoning"

— STUDENT SHEET 6.3
  "Sharing Claims
   and Evidence"

— STUDENT SHEET 6.4
  "Writing Frame: Evidence
   and Trade-Offs Letter"
   (OPTIONAL)

— VISUAL AID 1.2
  "Scoring Guide: Evidence
   and Trade-Offs (E&T)"
   (OPTIONAL)

Arrange for classroom computer use and familiarize yourself with the simulation found at https://sepup. lawrencehallofscience.org/lake-timtim-evidence-simulation/.

If you do not have computer accessibility, you can create a printed version of this activity by printing the Evidence cards from the simulation found at the end of this Teacher Edition activity. Refer students to the screenshots of the simulation found in the Student Book. Read through the student and teacher instructions to further determine how to modify the activity for use offline with your students.

At the end of this activity, student groups present their claims and evidence. Decide how you would like your students to present their ideas to the class. You may ask students to make a poster, a digital slide presentation, or an oral presentation. There are also opportunities for extended writing identified in teaching notes. Decide if you would like students to do the writing activities, whether you would like them to use the writing frames provided, and how you will scaffold the writing process for students.

TEACHING NOTES

> Suggestions for **discussion questions** are <mark>highlighted in gold.</mark>
>
> Strategies for the **equitable inclusion** are <mark>highlighted in blue.</mark>

GETTING STARTED (10 MIN)

1   Review the evidence about Skipton's water quality in the previous activities.

• Remind students that in Activity 1, they made a decision about using water from the Mizu River vs. Lake Timtim. In this activity, they will further investigate Lake Timtim.

• Ask, <mark>"What evidence do you have so far about Skipton's water quality?"</mark> Students may recall the turbidity data based on the observations of some residents, which did not align with the treatment plant data and which found that the water met quality standards for turbidity. Students may point out that there was limited data about different water quality indicators as well as the test results of these indicators.

2   Review the idea of a claim.

• Use the introduction to review the idea of a claim, which was first introduced in Activity 1. In general, a **claim** is a statement that asserts something is true. In science, scientists make claims based on experimental results or other evidence.

• Discuss the relationship between a claim and evidence. You may wish to clarify the following points:

   – When data is used to support or refute a claim, it is called evidence.

   – When evaluating a claim, scientists consider how evidence is related to a claim and whether the evidence supports or refutes the claim.

   – When evidence is consistent with the claim or makes the claim stronger, the evidence is said to support the claim.

   – When evidence is contrary to or makes the claim weaker, the evidence is said to refute the claim.

PROCEDURE SUPPORT (90 MIN)

3   **Present the scenario of Skipton's city council from Procedure Part A, Step 1.**

- In this scenario, Skipton's city council is gathering more evidence with which to make a decision about the city's water source. The scenario can be shared with the class in multiple ways: You can read it aloud to the class (using a storytelling approach), have individual students read the paragraph aloud to the class while others follow along with the text, or have students read it individually or cooperatively in their groups of four.

- Depending on your student population, use oral storytelling to support diverse learners in decoding scientific ideas and constructing meaning and ask questions about the main points of the scenario to ensure comprehension. Students can refer to the text in the Student Book as needed.

- Review the four claims that students will evaluate. You might find it helpful to review the geography of the Skipton area by projecting Visual Aid 6.1, "Map of the Skipton Area."

4   **Assign students a claim and background information to read and review.**

- Be aware when assigning groups that Claims 3 and 4 have evidence that is easier to interpret and understand, while Claims 1 and 2 have evidence that requires evaluating long-term trends and making more inferences.

- Support students, particularly English learners (ELs), in sensemaking and language acquisition as they read their claims and background information. Circulate around the room and check in, especially with ELs, to support them in using the strategy to decode scientific ideas and construct meaning as they read.

- Some of the evidence in the simulation is presented as graphs. If you have students who struggle with interpreting graphs, use Visual Aid 6.3, "Interpreting Graphs," to review these skills.

5   **Students explore the computer simulation.**

- Inform students that they will use a computer simulation to gather more evidence related to these claims. Go to the simulation of Lake TimTim at https://sepup.lawrencehallofscience.org/lake-timtim-evidence-simulation/

- First, give students time to explore the simulation freely. After they've had a few minutes to familiarize themselves with the simulation, ask them to share what they observe, such as the types of features the simulation has and the types of information that it provides.

- Help orient students to the simulation by pointing out that the evidence at Location 7 is from Wazi Lake, a lake 200 miles away from Lake Timtim. The rest of the data is from various locations around Lake Timtim.

• Have students save a piece of evidence and enter Evidence mode. Point out that they will use this mode to sort the evidence related to their claim. Remind them that when they first look at data or observations at each location, they should first decide whether that information can be used as evidence related to their claim. Switch back to Map mode and show them the clear saved Evidence button to reset the evidence.

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TEACHER'S NOTE: The simulation has a few intentional features to be aware of. First, evidence
                for each claim is addressed at only two locations on the interactive map.
                Students are not aware of this as they begin to examine the evidence because
                their first goal is to practice identifying evidence that is relevant to their
                assigned claim. Second, when saving evidence, the simulation has a preset limit
                of eight Evidence cards that can be saved from the Map mode. This function is
                meant to help remind students that they should be saving only evidence that is
                relevant to their claim. Students will get an alert if they try to save more
                than eight Evidence cards. If they want to change their saved evidence, they
                will need to reexamine their saved evidence and unsave prior evidence before
                they can save more.
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6   **Students gather evidence about their claim in the Map mode of the simulation.**

• If needed, demonstrate how to find and save relevant evidence in the simulation.

• After seeing the first piece of evidence at a particular location, students can select Gather More Evidence for more evidence related to the first evidence card at that location.

• Students can look at the locations in any order, and they should continue exploring, saving Evidence cards, and gathering more evidence until they have gone through all eight locations. The simulation tracks which locations they have looked at and where they have saved evidence by using colored circles under each location number. (White: unviewed data; gray: viewed data; green: saved evidence).

• Remind students that their focus as they look through the map locations is to find evidence that is relevant to their claim. You might use the following questions to model for students how to determine if the evidence is relevant to their claim:

   – Is the evidence telling me information that is on the same topic as my claim?

   – Does this evidence tell me anything new about my claim?

   – Does this evidence make me think of any questions related to my claim?

• Circulate and assist students as needed. Remind them that they should be working in Map mode and looking for and saving evidence that is relevant to their claim.

7 **Students evaluate the evidence in the Evidence mode of the simulation.**

• When students have finished working in Map mode, hand out Student Sheet 6.1, "Assessing My Evidence." Students should use it to record if their saved evidence is relevant and whether it supports or refutes their claim, as well as any explanations they may have about their sorting. As students complete Student Sheet 6.1, they can begin to determine whether the evidence they have supports or refutes their assigned claim. At the bottom of Student Sheet 6.1, they are asked to determine if the evidence as a whole supports or refutes their claim.

• If needed, review how students can use Evidence mode of the simulation, which shows all the evidence that students saved from the map. Students will now think more deeply about how each piece of evidence is related to the claim they are investigating.

• Remind students that they will have to make inferences about the observations or data in the Evidence cards—they will need to form ideas about what each piece of data means and how it applies to the claim.

• If you would like students to screenshot the final sort of their evidence, give them instructions (e.g., using computer commands, using a phone) and let them know how to provide the image to you.

8 **Have pairs who have investigated the same claim share their findings.**

• Assign students to work with another pair who investigated the same claim. Students should compare their evidence and conclusions about their claim. If students need more support, you might suggest that they discuss the following questions with their group:

  – Did the other pair find the same evidence as you?

  – Did the other pair have similar or different ideas about how the evidence related to the claim?

  – Did the other pair have any evidence or ideas that made you change your thinking about the claim and evidence?

• Distribute Student Sheet 6.2, "Writing Frame: Claims, Evidence, and Reasoning," which can help students summarize their claim and evidence related to their claim.

9 **Students present their claim and relevant evidence to the class.**

• Students should share with the class their claim, the relevant evidence, and whether the claim was supported or refuted. Instruct students on how you would like them to present their information to the class. Possible formats include:

  – a short oral presentation

  – 1–2 slides in a digital presentation

  If appropriate, review expectations for presentations.

- Hand out Student Sheet 6.3, "Sharing Claims and Evidence," before students begin their presentations. Students should record notes on the other claims and evidence. Inform students that they will make a recommendation to Skipton's city council regarding whether Lake Timtim should be used as a water source based on multiple lines of evidence, which the other claims will provide.

- Foreshadow Build Understanding item 5, which asks students to consider how much evidence might be considered enough to make a *decision*. Note that while the question asks about the application of evidence, it relates to a decision, while in the activity, students are evaluating a claim. Since a *claim*, even one based on evidence, still comes with some uncertainty, making a decision based on that claim often requires trade-offs of cost and/or risk. Ask student groups to address the quality and quantity of evidence related to their claim by asking questions such as:

How confident are you about whether your claim was supported or refuted based on the evidence that you found? What would make you feel more sure? Responses will vary depending on the claim and how students interpreted different evidence. Claim 1 (The algae in Lake Timtim is harmless.) has evidence that refutes it. Students may feel very confident that the algae in the lake is harmful due to the graphs and water-sample readings that identified the presence of potentially harmful algae species and algal toxins. Since it is not clear whether there is enough harmful algae in the lake to be a threat to humans, additional data about whether there was algal toxin found in the tissue of the dead organisms would increase students' confidence levels.

Did you have evidence from multiple sources to support or refute your claim? Did this make you feel more confident or less confident about your claim? Students should have found at least 4–6 different types of evidence to support or refute each claim. Having multiple lines of evidence is likely to increase confidence levels. For example, students investigating Claim 3 might state that the combination of Secchi disk measurements and turbidity meter readings from around the lake comparing past data to current data made them very confident that their claim was supported.

10 **Student groups discuss their recommendation to Skipton's city council.**

- In Procedure Step 11, student groups revisit their recommendation(s) from Procedure Step 7, which was based solely on evidence related to their individual claim (and prior evidence from the unit). They now have evidence for all four of the claims and can re-evaluate their decisions based on these multiple lines of evidence.

SYNTHESIS OF IDEAS (10-15 MIN)

11 **Discuss the role of human senses and scientific technology in evidence.**

- Use Visual Aid 6.2, "Invention Timeline," to share how the scientific tools and technology described in this activity have developed over time.

- Highlight how evidence was provided by both human senses and scientific technology by asking:

What can human senses provide that scientific tools and techniques cannot? What can scientific tools and techniques provide that human senses cannot? Some possible responses are that human senses can help people notice things and direct attention to a problem. However, there is only so much information that senses can provide. Human senses cannot make precise measurements or see things that are very small or very big. That is why scientific tools, techniques, and technology are helpful.

How do evidence from human senses and scientific tools and technology build on one another? Is it important to have both sense observations and data from scientific tools and techniques? Why? Students might mention that human senses can often provide the first step in motivating more investigation—people notice something is wrong, such as cloudy water or dead organisms, and then want to learn more. Sometimes the results of data from technology need to be validated by human senses. A satellite image might seem to indicate one thing, but people may need to visit the place to make direct observations to confirm it.

You encountered the idea of validation of data in an earlier activity. What are some examples from the simulation where evidence from human senses or a scientific tool/technique was validated by another data source? Prompt students to think back to the claim they investigated in the simulation and then share their ideas. In Claim 1, human senses were able to observe algae in the water, which were validated by the microscope images of algae in the water. In Claim 2, decreasing water levels in the satellite images over time were validated by the observation of "bathtub rings." In Claim 3, the results of the Secchi disk measurements and turbidity meter data validated each other. In Claim 4, laboratory tests of water samples and soil samples provided similar data, validating the results.

12 **Discuss how new evidence about Lake Timtim affected decisions about the source of water.**

- Have students share their recommendations to Skipton's city council about the city's source of water. You may want students to:

    - answer the question as a warm-up at the start of the next class period.

    - do a quick-write in their science notebooks.

    - do a show of hands to see who would use Lake Timtim and who would not.

    - do a kinesthetic activity by having students who would use Lake Timtim move to one side of the room and those who would not use Lake Timtim move to the opposite side of the room.

- Discuss student recommendations as a class by asking questions such as:

  What evidence from other groups made you rethink your recommendation about Lake Timtim? Student responses will vary. They might indicate that hearing evidence from groups investigating other claims changed how they thought about the safety or availability of Lake Timtim's water. Hearing evidence from other groups may or may not have changed their recommendation.

  Do you think it is important to revise your thinking about a phenomenon when you get new evidence about it? Explain your reasoning. Students may agree that it is important to consider new evidence. It can make an explanation stronger or weaker or raise new questions to investigate.

  Why do you think it is important for decision-makers to think about a problem in different ways and with lots of different evidence before they make a decision? Decision-makers should consider as much evidence as possible because their decision affects others.

- For students who are visual learners, you can construct a table for them to list the various pieces of evidence they have seen thus far in the unit.

- While reviewing questions about claims and evidence, discuss the implications of having a claim refuted. Ask, Do you think it is a bad thing when a claim is refuted by evidence? Why or why not? Have students share ideas. When new evidence refutes a claim, it requires revisiting conclusions and explanations. New evidence that refutes an idea may require reconsidering problems in a new way. It may lead to a different question to investigate or the exploration of a new claim that could explain the evidence.

- Build Understanding item 1 can be assessed using <u>Scoring Guide</u>: Evidence and Trade-Offs (E&T). You may wish to provide students with Student Sheet 6.4, "Writing Frame: Evidence and Trade-Offs Letter."

- Use Build Understanding item 4 to revisit the application of multiple lines of evidence as a tool that can be used in everyday life. Ask students to share their everyday examples and how they utilize evidence to make those decisions. Discuss the amount and types of evidence that affect their decision-making, as well as other factors that may influence their choices.

EXTENSION (10 MIN)

13 Use the Extension as an opportunity for advanced learning.

Students select a water quality indicator and describe what information it can provide about water quality, why it's important, and its limitations. For example:

pH is an indicator of whether the water is acidic or basic. This type of information is important because many organisms can only survive within a certain pH range. The limitation of pH is that it is only one piece of evidence. Determining water quality requires information from lots of different water quality tests.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

① **E&T Scoring Guide**

What is your recommendation to the Skipton City Council about the use of Lake Timtim as a drinking water source? Write a letter supporting your answer with multiple lines of evidence and identifying the trade-offs of your decision.

A sample student response can be found here and on Student Sheet 6.4, Sample Student Response.

Level 4 response

Dear Skipton City Council,

My recommendation is that Lake Timtim not be used as a water source for Skipton. Tests of the water show that there is a small amount of toxic algae present. While it is not high enough to be a threat to humans, it could in the future. Second, data shows that Lake Timtim's water levels have been decreasing since 2000. Lake Timtim appears to follow the same water-level patterns as Wazi Lake, where water levels have also been declining. Third, Skipton and Lake Timtim are in an area that occasionally experiences drought, and it is likely that the lake would not be able to meet Skipton's water needs in these years. The trade-offs of not using this water source are that we will need to find a different water source to meet Skipton's needs and do tests on that water to see if it is safe enough and has enough supply for Skipton.

Sincerely,
Stu Dent

Level 3 response

Dear Skipton City Council,

I recommend Lake Timtim not be used as a drinking water source for Skipton. There is toxic algae present in the water. Water levels of the lake are decreasing. Lake Timtim is also in an area where there might be a drought. The trade-off is that we will need to find a different solution.

Sincerely,
Stu Denta

Level 2 response

Dear Skipton City Council,

I recommend that Skipton not use Lake Timtim as a source for drinking water. There might not be enough water because Lake Timtim's water levels are becoming lower. The trade-off is we still need water.

Sincerely,
Stu Dentbee

Level 1 response

Dear Skipton City Council,

Skipton should not use Lake Timtim for drinking water because there might be bad water quality.

Sincerely,
Stu Dentsy

② **In the simulation, each location provided different evidence, such as observations from human senses, results of lab tests, or data from scientific technology.**

   a **Select one site and describe all the evidence found at that location.**

At Location 6, there was a visual observation of ducks swimming in algae-filled water, followed by a visual observation of a dead fish on shore, and then a microscope image of algae in a water sample that turned out to be a toxic algae species.

   b **How could you improve the reliability of this data?**

I could improve the reliability by gathering data from many locations around the lake. If there are other places where ducks are swimming in algae and appear healthy, then that would make the conclusion that algae is probably not harmful and that the data are more reliable. I could examine the dead fish to determine how it died or visit other shoreline areas to see if there are other dead fish. For the microscope analysis, I could collect multiple water samples from the same area and from around different parts of the lake to see if there is harmful algae present. All these steps would increase the reliability of the data.

CONNECTIONS TO EVERYDAY LIFE

③ **Your teacher just told the class that soccer is the most popular sport in the world. What evidence could you collect (without using an Internet search) to evaluate this claim? Explain how this evidence would support or refute this claim.**

I could ask a bunch of people who are from different parts of the world what their favorite sport is. That would give me data that I can use as evidence to support or refute the claim. If most people say that soccer is their favorite sport, the claim would be supported.

④ **In your everyday life, how do you decide if you have enough evidence to support a decision? Explain your thinking by describing an everyday example, such as when you go to sleep or how you spend money.**

I don't think there is a set amount of evidence that is enough because there can always be more or new evidence. It's important to have some evidence, but sometimes one piece of evidence is more important than the rest. For example, I decide a lot of nights to stay up late. If I went to bed earlier, I would be less tired in the morning, I wouldn't be tardy, and I wouldn't fall asleep in class. One piece of evidence supporting my decision is homework: I have a lot of it. That is more important than any other evidence that says I should go to sleep early.

REFERENCES

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Which claim are you investigating?

- **CLAIM 1:** The algae in Lake Timtim is harmless.
- **CLAIM 2:** Lake Timtim will likely have water for another 100 years.
- **CLAIM 3:** The amount of suspended solids in Lake Timtim is decreasing.
- **CLAIM 4:** Lake Timtim does not contain levels of the chemical tributyltin (TBT) high enough to pose a health concern.

EVIDENCE CARD NUMBER AND BRIEF DESCRIPTION	IS THIS EVIDENCE RELEVANT TO YOUR CLAIM?		DOES THIS EVIDENCE SUPPORT YOUR CLAIM, REFUTE YOUR CLAIM, OR NEITHER?			EXPLAIN YOUR EVIDENCE (questions or thoughts you have, connections to other evidence, connections to the claim)
	YES	NO	SUPPORT	REFUTE	NEITHER	

Based on the evidence, my claim is ○ **SUPPORTED** ○ **REFUTED**

SAMPLE STUDENT RESPONSE CLAIM 1

Which claim are you investigating?

- **CLAIM 1:** The algae in Lake Timtim is harmless.
- ○ **CLAIM 2:** Lake Timtim will likely have water for another 100 years.
- ○ **CLAIM 3:** The amount of suspended solids in Lake Timtim is decreasing.
- ○ **CLAIM 4:** Lake Timtim does not contain levels of the chemical tributyltin (TBT) high enough to pose a health concern.

EVIDENCE CARD NUMBER AND BRIEF DESCRIPTION	IS THIS EVIDENCE RELEVANT TO YOUR CLAIM?		DOES THIS EVIDENCE SUPPORT YOUR CLAIM, REFUTE YOUR CLAIM, OR NEITHER?			EXPLAIN YOUR EVIDENCE (questions or thoughts you have, connections to other evidence, connections to the claim)
	YES	NO	SUPPORT	REFUTE	NEITHER	
1A: photo of green film on a rock in the lake	X			X		*The green film on the rock and the smell can indicate that blue-green algae is in the water. Blue-green algae can be harmful. We need more info about what type of algae it is.*
1B: pie graph of algae populations	X			X		*Most of the algae in Lake Timtim is not toxic, but there is a small population of potentially toxic algae. Is it enough to be harmful to humans?*
1C: line graph algae toxin measure measurement	X			X		*Currently there is Microcystis toxin present in the lake, indicating that there are harmful algae present. In the past, the levels of algal toxin in the lake water have been unsafe to drink.*
3A: ducks swimming in algae water	X				X	*The ducks are swimming in the water. They seem okay, but we don't actually know what happens to them.*
3B: dead fish	?			X		*Could the algae be the cause of the dead fish? Maybe. I need to know if there's algae toxin in/on the dead fish.*
3C: microscope analysis of Microcystis algae	X			X		*Microscope image of the water sample is Microcystis, a toxic algae.*

Based on the evidence, my claim is   ○ SUPPORTED   ● REFUTED

SAMPLE STUDENT RESPONSE CLAIM 2

Which claim are you investigating?

○ **CLAIM 1:** The algae in Lake Timtim is harmless.
● **CLAIM 2:** Lake Timtim will likely have water for another 100 years.
○ **CLAIM 3:** The amount of suspended solids in Lake Timtim is decreasing.
○ **CLAIM 4:** Lake Timtim does not contain levels of the chemical tributyltin (TBT) high enough to pose a health concern.

EVIDENCE CARD NUMBER AND BRIEF DESCRIPTION	IS THIS EVIDENCE RELEVANT TO YOUR CLAIM?		DOES THIS EVIDENCE SUPPORT YOUR CLAIM, REFUTE YOUR CLAIM, OR NEITHER?			EXPLAIN YOUR EVIDENCE (questions or thoughts you have, connections to other evidence, connections to the claim)
	YES	NO	SUPPORT	REFUTE	NEITHER	
7A: Wazi Lake has low water levels	X			X		*This evidence is for Wazi Lake, a nearby lake which also has low water levels. The data is only for one year, so I wonder what the trend is?*
7B: satellite images of Wazi Lake over time	X			X		*Wazi Lake water levels have had big reductions in water level since 2000. Lake Timtim is nearby with similar geography and climate and likely to follow the same pattern.*
7C: line graph of Wazi Lake surface levels	X			X		*Wazi Lake's water surface levels have decreased since 2000. Lake Timtim is nearby and likely to follow the same pattern.*
8A: observation of part of Timtim shoreline that is lower than usual	X			X		*Lake Timtim levels are lower than the previous year.*
8B: line graph of water levels of Timtim	X			X		*Lake Timtim's water levels are trending down over time.*
8C: climate data for Skipton area	X			X		*The climate data indicate that the area sometimes experiences drought, which could make the lake levels go down.*

Based on the evidence, my claim is   ○ SUPPORTED   ● REFUTED

SAMPLE STUDENT RESPONSE CLAIM 3

Which claim are you investigating?

○ **CLAIM 1:** The algae in Lake Timtim is harmless.
○ **CLAIM 2:** Lake Timtim will likely have water for another 100 years.
● **CLAIM 3:** The amount of suspended solids in Lake Timtim is decreasing.
○ **CLAIM 4:** Lake Timtim does not contain levels of the chemical tributyltin (TBT)
    high enough to pose a health concern.

EVIDENCE CARD NUMBER AND BRIEF DESCRIPTION	IS THIS EVIDENCE RELEVANT TO YOUR CLAIM?		DOES THIS EVIDENCE SUPPORT YOUR CLAIM, REFUTE YOUR CLAIM, OR NEITHER?			EXPLAIN YOUR EVIDENCE (questions or thoughts you have, connections to other evidence, connections to the claim)
	YES	NO	SUPPORT	REFUTE	NEITHER	
2A: cloudy and clear water samples	X		X			*Lake Timtim's water sample from this year is clearer than last year.*
2B: Secchi disk measurements	X		X			*The current measurement is much deeper, indicating that there is less turbidity than before.*
2C: additional Secchi disk readings	X		X			*The measurements from around the lake confirm that the turbidity has decreased since 1988.*
5A: cloudy water after a storm	X				X	*It is cloudy, but we don't have data from the past to compare.*
5B: satellite images of sediment levels after storm	X				X	*The lake has more sediment right after the storm, and it decreases a couple weeks after the storm. But this is not really related to whether the turbidity is decreasing over the long term.*
5C: graph showing amount of suspended solids	X		X			*The average turbidity meter readings show that turbidity has decreased since 2012, and the current levels are within safety guidelines.*

Based on the evidence, my claim is ● SUPPORTED ○ REFUTED

SAMPLE STUDENT RESPONSE CLAIM 4

Which claim are you investigating?

○ **CLAIM 1:** The algae in Lake Timtim is harmless.
○ **CLAIM 2:** Lake Timtim will likely have water for another 100 years.
○ **CLAIM 3:** The amount of suspended solids in Lake Timtim is decreasing.
● **CLAIM 4:** Lake Timtim does not contain levels of the chemical tributyltin (TBT) high enough to pose a health concern.

EVIDENCE CARD NUMBER AND BRIEF DESCRIPTION	IS THIS EVIDENCE RELEVANT TO YOUR CLAIM?		DOES THIS EVIDENCE SUPPORT YOUR CLAIM, REFUTE YOUR CLAIM, OR NEITHER?			EXPLAIN YOUR EVIDENCE (questions or thoughts you have, connections to other evidence, connections to the claim)
	YES	NO	SUPPORT	REFUTE	NEITHER	
4A: dead fish on the shore	?				X	TBT can be toxic to animals. Did the fish die because of TBT exposure?
4B: TBT measurements in the lake bed and soil at shore	X		X			Both of the levels reported are less than the TBT maximum.
4C: tissue samples found little TBT	X		X			The TBT found in the tissues of the dead organisms are less than the TBT maximum. So it seems like the TBT is not the cause of the dead fish.
6A: the water is clear and odorless at this location		X			X	You can't tell by looking at the water whether or not there is TBT in it.
6B: Timtim TBT measurements from 2005–2015	X		X			TBT has been decreasing over time and was below safety maximum levels from 2014–2015. But what about current levels?
6C: current water sample TBT measurements	X		X			Current TBT measurements are far below the maximum safety values.

Based on the evidence, my claim is ● SUPPORTED ○ REFUTED

THE CLAIM I INVESTIGATED WAS

_____

BASED ON MY INVESTIGATION, I THINK THE CLAIM WAS ○ **SUPPORTED** ○ **REFUTED**

THE FIRST LINE OF EVIDENCE THAT ○ **SUPPORTS** ○ **REFUTES** **MY CLAIM IS**

_____

MY REASONING FOR HOW/WHY THIS EVIDENCE ○ **SUPPORTS** ○ **REFUTES** **MY CLAIM IS THAT**

_____

THE SECOND LINE OF EVIDENCE THAT ○ **SUPPORTS** ○ **REFUTES** **MY CLAIM IS**

_____

MY REASONING FOR HOW/WHY THIS EVIDENCE ○ **SUPPORTS** ○ **REFUTES** **MY CLAIM IS THAT**

_____

THE THIRD LINE OF EVIDENCE THAT ○ **SUPPORTS** ○ **REFUTES** **MY CLAIM IS**

_____

MY REASONING FOR HOW/WHY THIS EVIDENCE ○ **SUPPORTS** ○ **REFUTES** **MY CLAIM IS THAT**

_____

SAMPLE STUDENT RESPONSE

THE CLAIM I INVESTIGATED WAS

Claim 2: Lake Timtim will likely have water for another 100 years.

BASED ON MY INVESTIGATION, I THINK THE CLAIM WAS ○ SUPPORTED ● REFUTED

THE FIRST LINE OF EVIDENCE THAT ○ SUPPORTS ● REFUTES **MY CLAIM IS**

The line graph shows that Lake Timtim's water levels have been trending down since 2000.

MY REASONING FOR HOW/WHY THIS EVIDENCE ○ SUPPORTS ● REFUTES **MY CLAIM IS THAT**

If Lake Timtim's water levels continue following the same trend, the lake will run out of water in a few decades.

THE SECOND LINE OF EVIDENCE THAT ○ SUPPORTS ● REFUTES **MY CLAIM IS**

The climate data shows that sometimes the Skipton/Lake Timtim area experiences low rainfall years and varying degrees of drought.

MY REASONING FOR HOW/WHY THIS EVIDENCE ○ SUPPORTS ● REFUTES **MY CLAIM IS THAT**

In drought years, it is possible that water levels in Lake Timtim could fall below what is needed to support Skipton, since rainfall is one of the main factors that affect lake water levels.

THE THIRD LINE OF EVIDENCE THAT ○ SUPPORTS ● REFUTES **MY CLAIM IS**

The satellite and water-level data about Wazi Lake showed that water levels there have been decreasing since 2000.

MY REASONING FOR HOW/WHY THIS EVIDENCE ○ SUPPORTS ● REFUTES **MY CLAIM IS THAT**

Wazi Lake is only 200 miles away from Lake Timtim. Because weather patterns and droughts tend to affect large areas in a similar way, Lake Timtim water levels are likely to follow the same patterns as Wazi Lake. This means Timtim water levels will likely continue to decrease over time.

As you listen to your classmates present about their claims and evidence, record notes in the following table. This information will help you with your recommendation to Skipton's City Council.

CLAIM	SUPPORTED OR REFUTED	MAIN EVIDENCE PRESENTED	OTHER NOTES
CLAIM 1 **The algae in Lake Timtim is harmless.**			
CLAIM 2 **Lake Timtim will likely have water for another 100 years.**			
CLAIM 3 **The amount of suspended solids in Lake Timtim is decreasing.**			
CLAIM 4 **Lake Timtim does not contain levels of the chemical tributyltin (TBT) high enough to pose a health concern.**			

SAMPLE STUDENT RESPONSE

As you listen to your classmates present about their claims and evidence, record notes in the following table. This information will help you with your recommendation to Skipton's City Council.

CLAIM	SUPPORTED OR REFUTED	MAIN EVIDENCE PRESENTED	OTHER NOTES
CLAIM 1 **The algae in Lake Timtim is harmless.**	*Refuted* *(by evidence at locations 1 and 3)*	*There is a small population of algae in the lake that could potentially include harmful algae species.* *The toxin-producing algae species Microcystis has been identified in at least one location of the lake.* *Although the levels of algae toxin are currently within safe levels, there have been unsafe levels of algae toxin in the past.*	*Although toxic algae is present in the lake, the current population is not very high, and the toxin levels are within safety limits.* *Timtim might still be a good water source as long as the water is monitored closely.*
CLAIM 2 **Lake Timtim will likely have water for another 100 years.**	*Refuted* *(by evidence at locations 7 and 8)*	*Lake Timtim's water levels have been trending down since 2000.* *The region is prone to drought, even though it is not currently experiencing a drought.* *Comparing data from nearby Wazi Lake shows that the water levels at that lake have also decreased in the past 20 years. Timtim could follow similar patterns.*	*Lake Timtim could still be a good choice for Skipton's water in the short term because it currently has enough water (and has for the last 10 years), and the water currently meets safety guidelines.*
CLAIM 3 **The amount of suspended solids in Lake Timtim is decreasing.**	*Supported* *(by evidence at locations 2 and 5)*	*Current Secchi disk measurements from around the lake have shown increased Secchi depths compared to past readings.* *Turbidity meter readings comparing past data to current data have shown that the present turbidity levels measured around the lake are lower than in past years.*	*The data did show that turbidity levels can change after events like severe storms, but those changes are temporary.* *The lower turbidity is a sign that the water quality has improved.*
CLAIM 4 **Lake Timtim does not contain levels of the chemical tributyltin (TBT) high enough to pose a health concern.**	*Supported* *(by evidence at locations 4 and 6)*	*The evidence shows that although TBT is still present in the water and soil samples, it is not a high enough level to pose a risk to humans and wildlife.* *TBT levels in the water have decreased over time.* *Tests on dead organisms found at the lake showed levels of TBT within safety guidelines.*	*Although the soil samples from Lake Timtim z that significant amounts of TBT were still present in the lake bed, all the soil and water samples contained TBT levels well under the maximum levels. TBT doesn't seem like it is a concern for this lake.*

Dear Skipton City Council,

There has been a lot of discussion about the issue of which drinking water source is the best for Skipton. My recommendation is that

My recommendation is based on the following evidence:

First,

Second,

Third,

The trade-off(s) of using this water source are

People who disagree with my recommendation might say that

Even with these counter-arguments and trade-offs, I stand by my recommendation because

Sincerely,

Dear Skipton City Council,

There has been a lot of discussion about the issue of which drinking water source is the best for Skipton. My recommendation is that

Lake Timtim should be used as a water source for Skipton.

My recommendation is based on the following evidence:

First,

Tests of the water show low levels of toxic chemicals such as TBT.

Second,

Tests of the water show that there is not enough algal toxin to be a concern for humans.

Third,

Lake Timtim water levels have been higher than the needs of Skipton residents when you look at water levels over the last 20 years.

The trade-off(s) of using this water source are

That we may need to do regular testing of the water to make sure that algae levels don't reach toxic levels. We might also need to conserve water or find additional water sources in years when there is extreme drought.

People who disagree with my recommendation might say that

Lake Timtim might be dangerous to humans at some point due to the presence of a small amount of toxic algae. They might also say that Lake Timtim won't last 100 years.

Even with these counter-arguments and trade-offs, I stand by my recommendation because

I believe that Lake Timtim is a safe solution to Skipton's water problem.

Sincerely, _____

CLARITY
MOUNTAINS

SKIPTON

MIZU
RIVER

LAKE
TIMTIM

AQUAVILLE
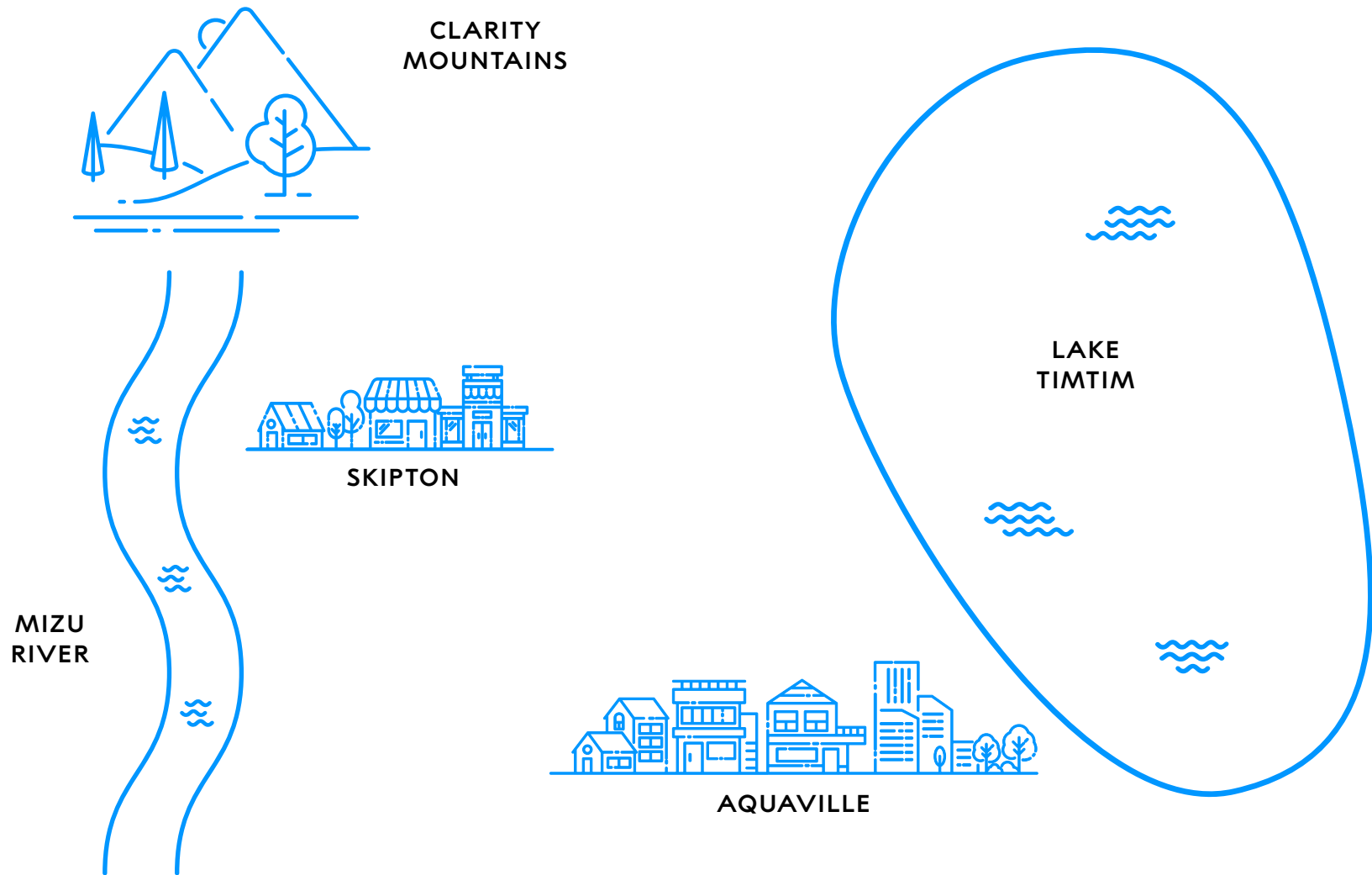
	INVENTION	INVENTOR
1865	Secchi disk	Italian priest Angelo Secchi
1912	mass spectrometer	British physicist J. J. Thomson (best known for his discovery of the electron)
1931	scanning electron microscope (prototype)	German physicist Ernst Ruska and electrical engineer Max Knoll
1952	gas chromatography	British scientists Anthony T. James and Archer J. P. Martin*
1955	gas chromatography-mass spectrometry (GC-MS)	Dow Chemical scientists Fred McLafferty and Roland Gohlke
1959	first satellite image of Earth	U.S. National Aeronautics and Space Administration (NASA) [image taken by *Explorer 6* satellite]

*German scientist Erika Cremer's unpublished 1944 paper on gas chromatography and the laboratory where she worked were both destroyed during World War I. In 1951, she published several papers on gas chromatography in lesser-known German journals, and her work remained relatively unknown until after James and Martin's work was popularized.

Determine the path that describes the data.

IS THERE A RELATIONSHIP?

THERE IS A PATTERN.

RELATIONSHIP

THERE IS NO PATTERN.

NO RELATIONSHIP
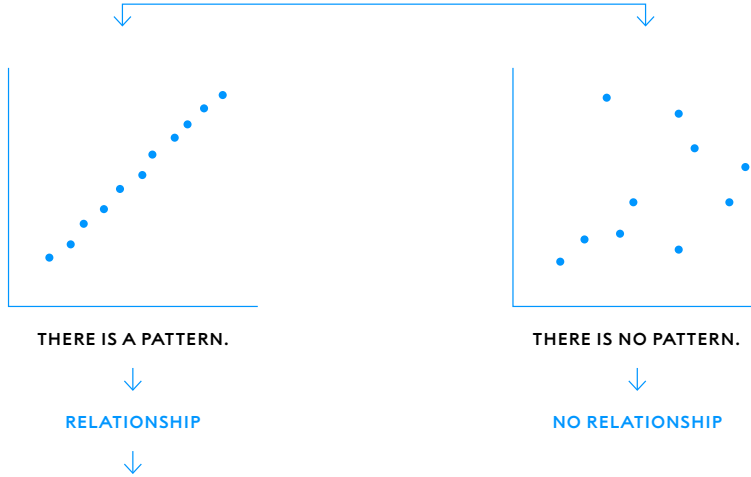
WHAT IS THE GENERAL TREND OF DATA?

POSITIVE

as x increases, y increases

CYCLICAL

as x increases, y repetitively increases and decreases

NEGATIVE

as x increases, y decreases

LINEAR

as x increases, y consistently increases *(sometimes called "direct")*

NONLINEAR

as x increases, y increases at a changing rate

LINEAR

as x increases, y consistently decreases

NONLINEAR

as x increases, y decreases at a changing rate *(sometimes called "inverse")*

ACTIVITY 6 : CLAIMS AND EVIDENCE

UNIT 1 : EVIDENCE & ITERATION IN SCIENCE

WHEN TO USE THIS SCORING GUIDE:

This Scoring Guide is used when students are making a choice or developing an argument about a socioscientific issue when arguments may include judgments based on nonscientific factors.

WHAT TO LOOK FOR:

• Response uses relevant evidence, concepts, and process skills to compare multiple options in order to make a choice.

• Response takes a position supported by evidence and describes what is given up (traded off) for the chosen option.

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 4 **Complete and correct**	The student provides a clear and relevant choice with appropriate and sufficient evidence, including BOTH of the following: • a thorough description of the trade-offs of the decision • reasons why an alternative choice was rejected (if applicable)	**The student's response includes:** • a clear description of their recommendation about using the lake as a water source. • a clear, thorough description of at least three lines of evidence that are relevant to and support their position. • a clear, thorough description of at least one appropriate trade-off.
Level 3 **Almost there**	The student provides a clear and relevant choice with appropriate and sufficient evidence, BUT one or both of the following are insufficient: • the description of the trade-offs • reasons why an alternate choice was rejected (if applicable)	**The student's response includes:** • a clear description of their recommendation about using the lake as a water source. • at least two lines of evidence that are relevant to and support their position. • at least one appropriate trade-off. • descriptions of evidence and trade-offs may be unclear or insufficient

LEVEL	GENERAL DESCRIPTION	ITEM-SPECIFIC DESCRIPTION
Level 2 **On the way**	The student provides a clear and relevant choice, BUT the evidence is incomplete.	**The student's response includes:** • a clear description of their recommendation about using the lake as a water source. • at least one line of evidence that is relevant to their decision. **And may include:** • at least one trade-off **However, evidence is less than three pieces and/or trade-off is missing or unclear.**
Level 1 **Getting started**	The student provides a clear and relevant choice BUT provides evidence that is subjective, inaccurate, or irrelevant.	**The student's response includes:** • a clear description of their recommendation about using the lake as a water source. **However, evidence is subjective, inaccurate, or irrelevant and/or trade-off is missing or unclear.**
Level 0	The student's response is missing, illegible, or irrelevant.	
X	The student had no opportunity to respond.	

EVIDENCE 1A

Swimmers noticed that some of the rocks at the edge of the water had a green film and a gasoline-like, fishy smell. These observations can indicate blue-green algae in the water.

EVIDENCE 1B

Types of Algae Found in Lake Timtim

- ● blue-green algae* 5%
- ● green algae 45%
- ● red algae 25%
- ● brown algae 25%

indicates a potentially toxic algae
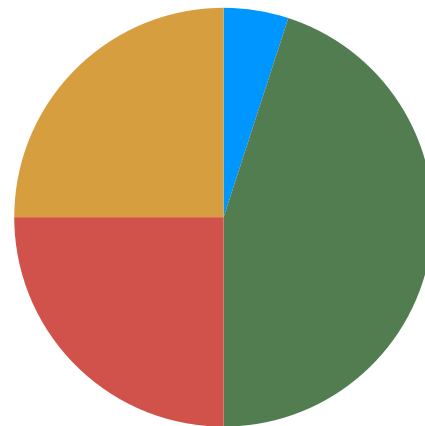
EVIDENCE 1C

Lake Timtim:
Average Algae Toxin Measurement

2012-2022

——— average algae toxin

·········· potentially unsafe for drinking water sources
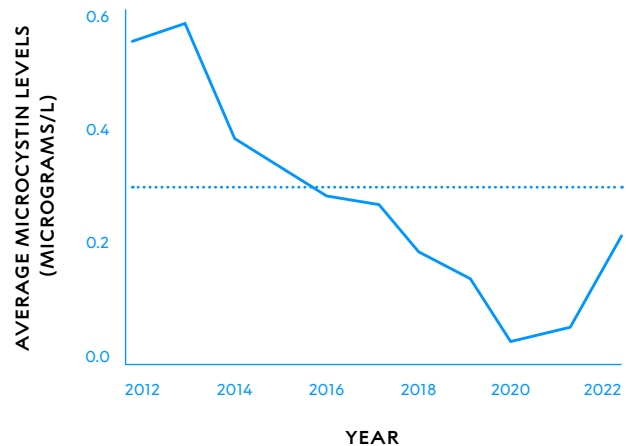
EVIDENCE 2A

Water samples at this location were collected to compare to samples from the previous year.

PREVIOUS YEAR   THIS YEAR

EVIDENCE 2B

Secchi disk measurements were conducted at the same location of the lake.

1988
1.7 m VISIBILITY

2023
8.0 m VISIBILITY

EVIDENCE 2C

Secchi disk measurements were conducted at the same locations of the lake.

1988 : 2.0 m
PRESENT : 8.5 m

1988 : 2.2 m
PRESENT : 7.5 m

1988 : 5.3 m
PRESENT : 10.0 m

1988 : 1.7 m
PRESENT : 8.0 m

1988 : 2.5 m
PRESENT : 7.1 m
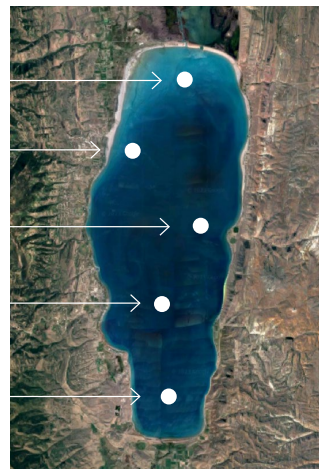
ACTIVITY 6 : CLAIMS AND EVIDENCE

UNIT 1 : EVIDENCE & ITERATION IN SCIENCE

EVIDENCE 3A

Boaters noticed ducks swimming in this part of the lake, which has a lot of algae.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 6

EVIDENCE 3B

A person fishing at this location noticed that there are several dead fish floating near the shore.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 6

EVIDENCE 3C

A water sample taken to the lab for microscope identification shows *Microcystis* blue-green algae present.
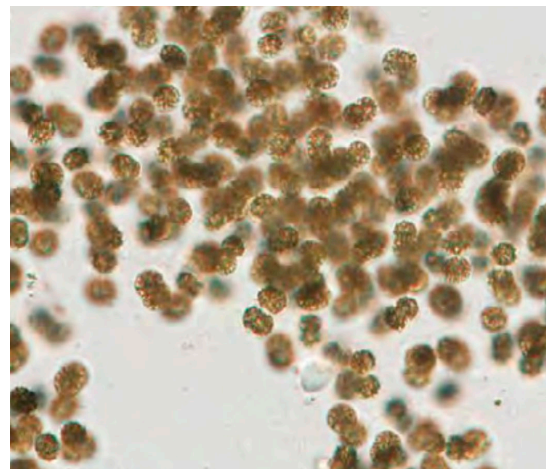
SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 6

ACTIVITY 6 : CLAIMS AND EVIDENCE

UNIT 1 : EVIDENCE & ITERATION IN SCIENCE

EVIDENCE 4A

A person fishing at this location noticed that there are several dead fish and a handful of shells on the shore.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 6

EVIDENCE 4B

Sediment samples from the shore and the lake bottom showed there was TBT in the soil sediments in 2023.
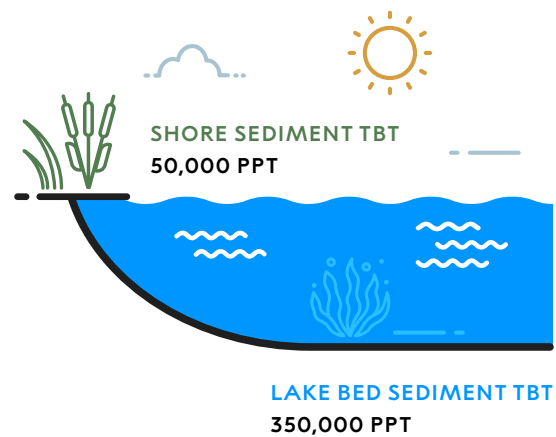
SCIENTIFIC THINKING FOR ALL: A TOOLKIT
UNIT 1: Evidence & Iteration in Science, Activity 6

SHORE SEDIMENT TBT
50,000 PPT

LAKE BED SEDIMENT TBT
350,000 PPT

EVIDENCE 4C

Tissue samples from the dead organisms found along the shore showed levels of TBT at 1,500 ppt.

SCIENTIFIC THINKING FOR ALL: A TOOLKIT
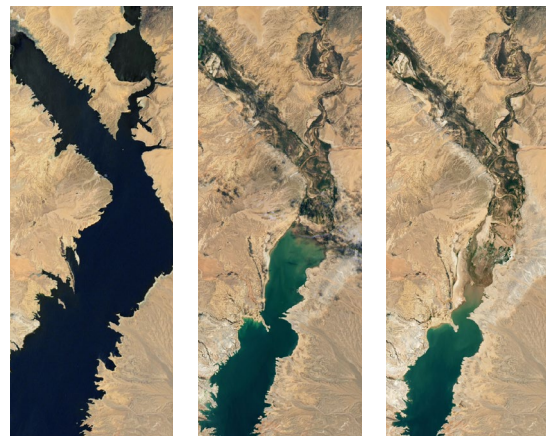UNIT 1: Evidence & Iteration in Science, Activity 6

EVIDENCE 5A

After a severe winter storm, the water looks more brown than usual.

EVIDENCE 5B

Satellite images of Lake Timtim 1 day after a severe storm compared to 3 weeks after the storm show changes in sediment levels in the lake.
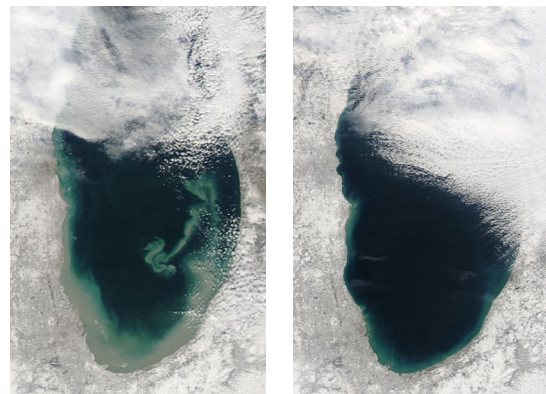
**1 DAY
AFTER SEVERE STORM**

**3 WEEKS
AFTER SEVERE STORM**

EVIDENCE 5C

Lake Timtim:
Average Turbidity Measurements

Multiple Locations 2012-2022

—— average turbidity

········ potentially unsafe for drinking water sources
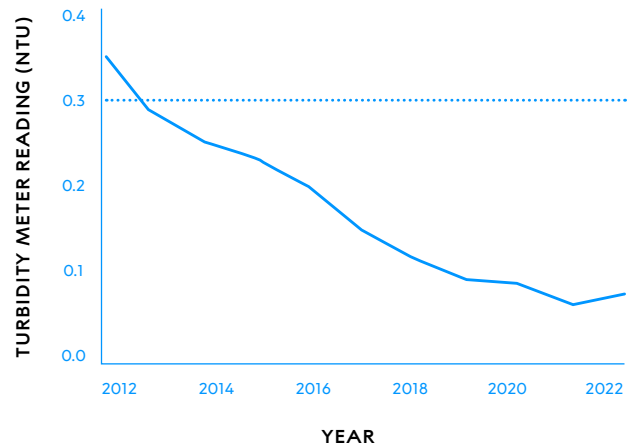
EVIDENCE 6A

The lake water at this location is clear and odorless.

EVIDENCE 6B

Measurements of TBT in Lake Timtim

2005-2015

——— tbt concentration

·········· potentially harmful to wildlife

- - - - maximum level for drinking water
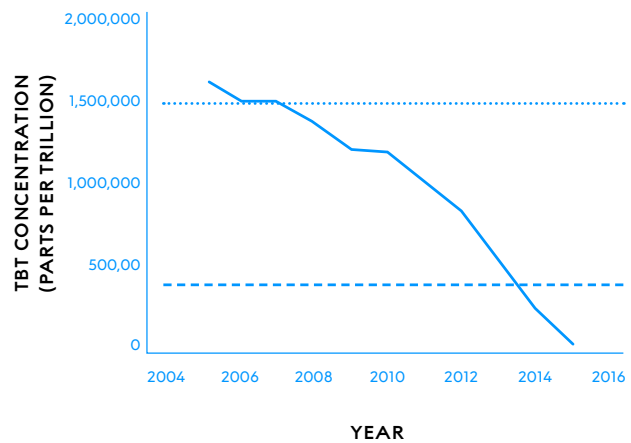
EVIDENCE 6C

Skipton University researchers tested water samples from Lake Timtim in 2023. The tests showed TBT at this location to be around 1,200 ppt.

EVIDENCE 7A

In 2023, visitors to nearby Wazi Lake could see a pale section of the canyon walls where the water level was below normal. These are sometimes called "bathtub rings."

EVIDENCE 7B

This series of satellite images of Wazi Lake was taken in July of 2000, 2010, and 2020.

2000   **2010**   **2020**

EVIDENCE 7C

Wazi Lake Monthly Elevation

2000-2022
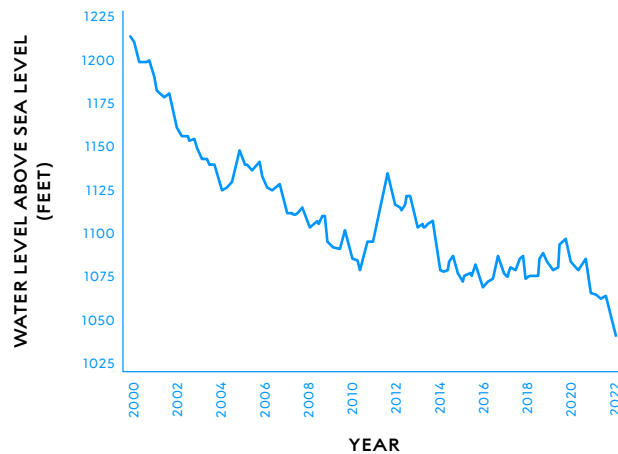
ACTIVITY 6 : CLAIMS AND EVIDENCE

UNIT 1 : EVIDENCE & ITERATION IN SCIENCE

EVIDENCE 8A

In 2023, visitors to Lake Timtim noticed that the water level of this section of shoreline was lower than the previous year.
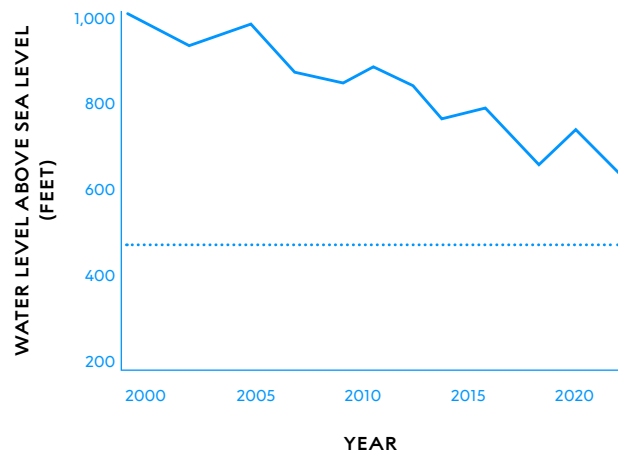
EVIDENCE 8B

Lake Timtim: Average Water Level

2000-2022

—————— water level

············· minimum lake level required
for Skipton's current usage

EVIDENCE 8C

Climate data and drought status for the Lake Timtim area were provided by Skipton University Dept. of Meteorology.

YEAR	AVERAGE TEMPERATURE (°C)	TOTAL PRECIPITATION (cm)	DROUGHT STATUS
2017	15.8	41.1	severe drought
2018	14.7	60.5	normal
2019	18.6	52.1	normal
2020	16.8	48.0	mild drought
2021	18.9	64.1	slightly wet
2022	15.9	51.3	mild drought