

The Clarity of Lake Tahoe

We plodded on, two or three hours longer, and at last the Lake burst upon us -- a noble sheet of blue water lifted six thousand three hundred feet above the level of the sea, and walled in by a rim of snow-clad mountain peaks that towered aloft full three thousand feet higher still As it lay there with the shadows of the mountains brilliantly photographed upon its still surface, I thought it must surely be the fairest picture the whole earth affords

Down through the transparency of these great depths, the water was not merely transparent, but dazzlingly, brilliantly so.

Roughing It, Mark Twain¹

When Mark Twain first saw Lake Tahoe in 1861, he was stunned by the glorious beauty of the sight: the vibrant blue of the lake's surface, the setting of the lake surrounded by the mountains, the amazing transparency of the water itself. Visitors to Lake Tahoe today often have the same reaction. The "fairest picture the whole earth affords" is, in large part, a consequence of the unusual clarity of the water in Lake Tahoe. This clarity gives the lake its brilliant blue color. But, today, that water clarity is in jeopardy. The Tahoe Basin now supports a thriving tourist industry with small cities, recreational communities, ski areas, golf courses, and casinos. Development around the lake has altered the delicate ecosystem of the Tahoe Basin. Erosion is now a serious problem; the runoff from the developed areas carries sediment and nutrients into the lake. The nutrients support the growth of algae, and both the algae and the sediments from the runoff work to cloud the water of Lake Tahoe.

Scientists regularly measure the clarity of the water in Lake Tahoe using a 25-centimeter white and black disk called a Secchi disk. The disk is lowered into the water until it disappears from sight. The depth at which the disk disappears from sight is called the Secchi depth. Thus, the Secchi depth is a measure of the water clarity for the lake. Measurements taken since 1970 indicate that the clarity of the water is decreasing over time.

The table below gives data for the clarity of the water in Lake Tahoe, measured as Secchi depth in feet, at five year intervals since 1970.

Water Clarity of Lake Tahoe	
year	clarity
1970	99
1975	92
1980	82
1985	79
1990	77
1995	71
2000	64
2005	72

Overview of the assignment:

Write a paper about Lake Tahoe water clarity. For your paper, construct a mathematical model to describe the clarity of the lake as a function of time, and present the model in your paper as an equation, a table, and a graph. Use all three representations of the model (ie. equation, table, and graph) to make the following four projections.

- the clarity level in the years 1992, 2010, 2050
- the year in which the clarity level will reach 30 feet

In your paper, interpret the model by describing, verbally, the trend of the model. Illustrate your description by providing the projections you made, above. Include a brief discussion of the level of confidence you have in each of the projections. Close your paper with any general thoughts you have about the future of Lake Tahoe water clarity. Before you begin to write the paper, be sure to complete some preliminary work.

Preliminary work:

- Start by defining variables.
- Enter the data into an Excel spreadsheet, and then use Excel to graph the data.
- Carefully select two data points from the graph; the goal is to select two points that will lead to a linear model that offers a good fit to the data. Use these two points, along with pencil and paper, to find an equation for the linear model.
- Use the equation for the linear model to add a model column to the Excel spreadsheet. Then graph both data and model. Spend some time making your graph look nice by providing a title for the graph, labeling the axes, constructing a helpful legend, and choosing pleasing shapes and colors. Save this work in Excel.
- Work with all three representations of your model (the equation, table, and graph) to make the projections given above. Make a note of each with pencil and paper.
- What is the slope of the model? What does the slope tell you about clarity over time?
- Note any thoughts you may have about the implications of the data, implications you may have found while working with the data. What are the data telling you about the water clarity of Lake Tahoe?

Writing your paper:

You are now ready to begin to write your paper. Using the preliminary work you have completed, go through the following process.

- Be sure to write an introduction
- Describe the data, the source of the data, and the process by which you worked with the data to obtain a mathematical model
- Define the variables you will use
- Introduce and present all three representations of the model
- Interpret the model: discuss the table and graph, and use the model to make projections. To what degree do you think each of the projections will be reliable? Why? Interpret the slope of your model in terms of the changing clarity of the lake.
- Write a conclusion that summarizes your thoughts about Lake Tahoe water clarity, as informed by your work with the data.

After the conclusion to your paper, be sure to include an appendix in which you show the algebraic work you did to support the derivation of the mathematical model and the projections that you made. Be sure to use correct mathematical notation when you write the mathematics in the appendix.