Testing for Phosphorus in Wastewater Name_____

Today you are going to look at data from phosphorus testing at WLSSD! Before we dive into the data, let's understand why phosphorus testing is so important in wastewater treatment.

Phosphorus is an important nutrient that helps plants grow, and it is found in wastewater from our homes and industries. But too much phosphorus in water can cause big problems. It leads to the excessive growth of algae which can lead to algae blooms that harm fish and other aquatic life.

To make sure our water is safe for everyone and the environment, governments have rules about how much phosphorus can be in wastewater that gets released. If wastewater treatment plants don't follow these rules, they can get in trouble. But it's not just about following the rules; it's also about keeping our water clean and healthy for animals and plants that depend on it. Testing for phosphorus helps workers at wastewater treatment plants know how much phosphorus is in the water they're treating. This way, they can adjust their methods to remove phosphorus effectively.

What happens to phosphorus removed from wastewater? Remember above, how phosphorus helps plants grow. Well in the right place, phosphorus is an important resource! After removing phosphorus from wastewater, we can reuse it for things like making fertilizers for farms. So, testing for phosphorus not only helps keep our water clean but also helps us be smart about using resources wisely.

Today, we're going to analyze phosphorus data from wastewater samples at WLSSD. You'll have the opportunity to make visual observations of color changes that occur during a test for phosphorus. In this test, reagents like ammonium molybdate and antimony potassium tartrate are combined with the water samples to determine how much phosphorus is present. Phosphorus in the water reacts with the reagents listed above which leads to a product that has a blue color. When more phosphorus is present in the water sample, the reaction forms a dark blue color. Less phosphorus in the water leads to a lighter blue color.

You will look at images of the water samples before and after the chemical reaction in various parts of the treatment plant. Before you do this, make some predictions:

1. What color do you think the water sample will be before the testing chemicals are added?
   A) Blue B) clear
2. What color do you think the water sample will be after adding the testing chemicals?
   A) Blue B) clear
3. A goal of wastewater treatment is to reduce the amount of phosphorus in the water. Which water sample do you expect to have more phosphorus? (circle your answer)

   A) the water that arrives at the wastewater treatment plant
   B) the treated water that leaves the wastewater treatment plant
4. When looking at the water samples that have been tested, how can you tell if there is more phosphorus or less phosphorus?

Qualitative Data (Visual Data)

Here is an image of water samples before and after the chemical reaction occurs:

Figure 1. Image of water sample prior to chemical reaction

Figure 2. Image of water sample after chemical reaction has occurred.

Below are photos of samples from after the chemical reaction occurs that tests for phosphorus and data. Your job is to try to determine which sample image matches each data point.

Figure 3. Images of wastewater samples after chemical reaction to test for phosphorus has occurred.

5. Recall that more phosphorus in the water leads to a darker blue color after the chemical reaction occurs. One the lines below, order the samples (A-E) from least phosphorus to most phosphorus.

_____ _____ _____ _____ _____

(LEAST) (MOST)

Quantitative Data (Numerical Data)

While **qualitative data** from visual observation is important, WLSSD is required to report the exact concentration of phosphorus in the water and ensure they are under the required limits. This exact concentration measured in mg/L is considered **quantitative data.**

6. Match the quantitative data with the images from above.

Phosphorus Concentration (mg/L)	**0.000**	**0.175**	**0.284**	**0.400**	**0.672**
Which water sample do you think corresponds to each data point? Write the sample letter A-E					

So what is mg/L? This stands for **milligrams per liter**, which is a really, really small number. One mg/L is like 7 drops of water in a full bathtub.
Milligrams per liter is also considered the same as **parts per million**. To get a visual of what 1 ppm is we can think about distances. One ppm is the equivalent of one inch in 16 miles (In Duluth, both Ordean-East Middle School and Lincoln Park Middle School are about 4 miles away from the Lift Bridge, so imagine the distance to the Lift Bridge and back, two times, and then only consider 1 inch of that distance). That is a small number. Even so, when considering the health of humans and the environment, small amounts of certain chemicals can make a very large impact.

Back to testing the wastewater! To measure the exact concentration of phosphorus, a spectrophotometer is used. This is a machine that measures wavelengths of light that travel through the blue solution to determine exactly how much phosphorus is in the sample of water. Below is the data that shows the average phosphorus concentrations over the course of a year.

Table 1. Data showing the monthly average of phosphorus measured in the water entering the treatment plant (influent) and the water leaving the treatment plant (effluent).

	Influent Phosphorus mg/L	Effluent Phosphorus mg/L
Apr 2023	1.5	0.58
May 2023	2.2	0.50
Jun 2023	2.5	0.47
Jul 2023	2.9	0.58
Aug 2023	2.6	0.81
Sep 2023	2.7	0.67
Oct 2023	2.9	0.75
Nov 2023	2.1	0.37
Dec 2023	1.9	0.48
Jan 2024	2.1	0.53
Feb 2024	2.4	0.51
Mar 2024	2.2	0.82
Apr 2024	1.8	0.46

7. Is there more phosphorus in the water entering or leaving the wastewater treatment plant?

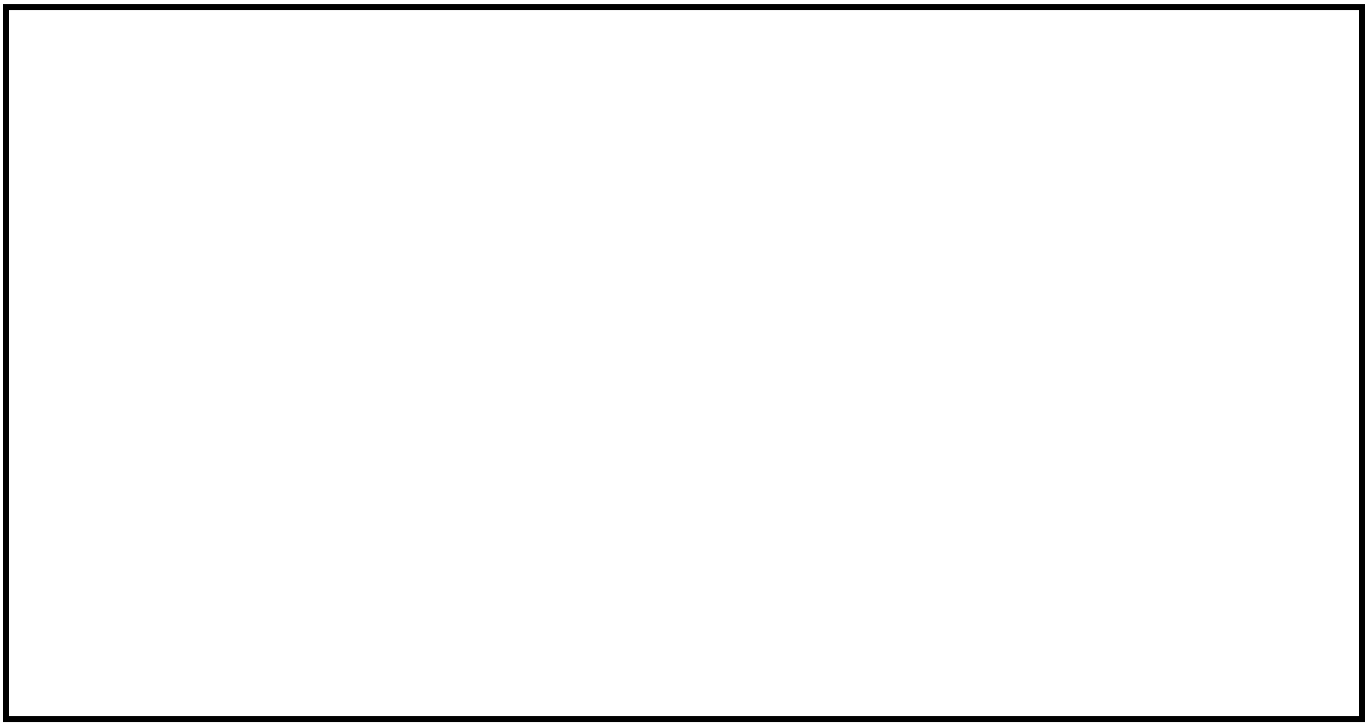
8. Is WLSSD reducing the phosphorus in the water?

9. What can be done with the phosphorus that is removed from the wastewater?

10. WLSSD has a permit limit of 1 mg/L for phosphorus in the effluent. Is WLSSD meeting that limit?

Make a Graph

A graph is a visual representation of data. Sometimes seeing the data in graph form is easier than seeing the numbers in a data table. In the space below make a graph of the data and then answer the questions.



11. The data that gets measured goes on the y axis. What is being measured?

12. What do you notice about the influent and effluent measurements?

13. During which two months are phosphorus levels the highest in the influent?

14. During which two months are phosphorus levels the lowest in the influent?

15. On average, WLSSD treats 130 million liters of wastewater each day. On an average day in August of 2023, how many kilograms of phosphorus are in the water that leaves the treatment plant?

16. How many kilograms did they prevent from entering the river on an average day in August 2023? Instead of going into the river, where was WLSSD able to put that phosphorus? (think back to the tour)

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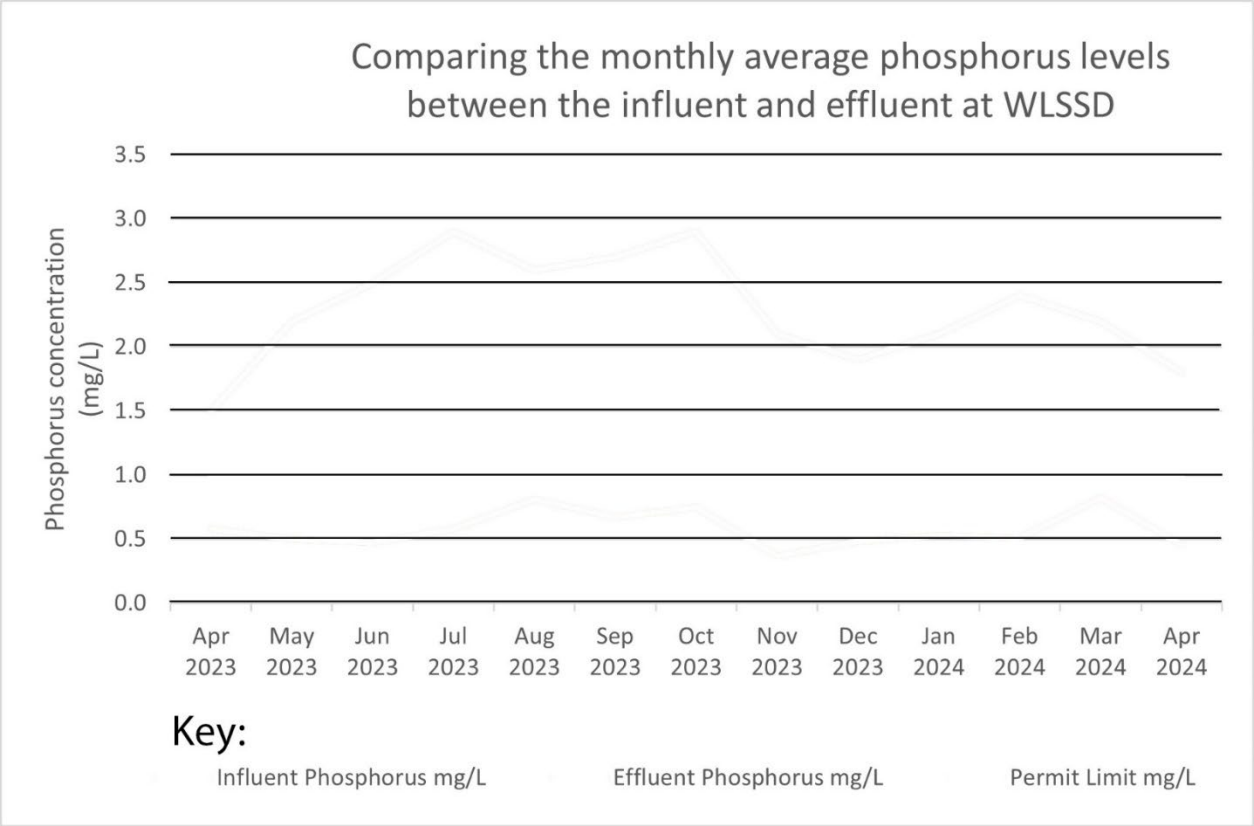

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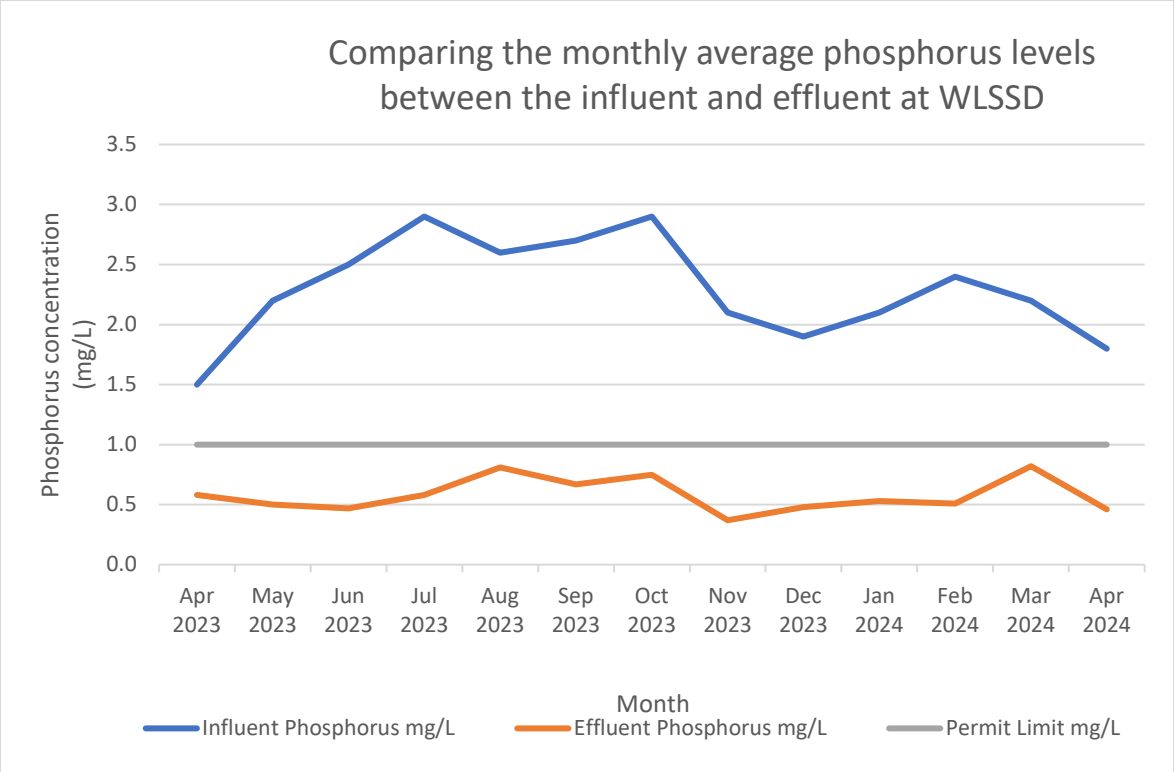

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