

# Orthophosphate & Total Phosphate

## Primary Importance:

Phosphorus is an essential nutrient for plant and animal life. It occurs naturally in the environment in small amounts. High levels of phosphorus can lead to algal blooms and excessive nutrients in the water. Fertilizers, detergents and sediment are major sources of added phosphorus in the environment.

## Problem

Most fresh water, but not all, is naturally deficient in phosphorus, thus algal growth is limited. If excessive phosphorus enters the surface waters, it can support rapid algal growth rates. When the algae die, their decomposition uses up oxygen and produces odors and toxins.

## Causes

- ❖ Phosphorus occurs naturally in geological and soil sources, and enriched groundwater can contain high levels of phosphorus.
- ❖ Phosphorus can come from manure sources, such as treatment lagoons, over-fertilized fields, and runoff from agricultural fields and turf grass.
- ❖ Suspended sediments are often a significant source of phosphorus. These may enter the stream via stream bank erosion or runoff from forestry, agriculture, and urban lands. In soils that contain it, phosphorus can be removed from particles and enter solution.
- ❖ Runoff from parking lots and urban lands is often excessively high in phosphorus. Inadequately treated municipal wastewater and septic tank effluent that has not fully reacted with soil are both sources of phosphorus.

## General Instructions:

All glassware to be used for these tests should be acid washed with a dilute hydrochloric acid solution (10:1) and triple washed with distilled water before each use. The glassware (droppers and tubes) should be dedicated for the purpose of analyzing phosphorus samples and should never be washed with detergent or soap as these often contain phosphorus.

## Orthophosphate vs. Total Phosphate

Orthophosphate readings include only the phosphate loose in the water, while Total Phosphate includes phosphate loose in the water in addition to phosphate connected to other molecules or substances in the water. Therefore, Orthophosphate (OP) is a component of Total Phosphate (TP), thus  $OP < TP$ . The Water Quality Index calls for the Total Phosphate reading, and should not be confused with the Orthophosphate reading.

## Range Tests

These tests have three levels: low, medium and high range. The “range” corresponds to the relative amount of chemical in the sample. If a high phosphate reading is suspected, the high range test (dilution) should be performed. If the high range test is not performed, the color change will be too dark to determine an accurate phosphate reading.

To determine which level of the Total Phosphate test to perform, you should complete the Orthophosphate test first because the Total Phosphate test is time consuming and will be ruined if the appropriate range test is not chosen. Start with the Low-range test. If the reading is above 1 mg/L, there is a shortcut for the Medium-range test. If the reading is still too high, ( the color is

too dark to read accurately with the color wheel), complete the High-range test. By doing this, you will know which range of test to complete for the Total Phosphate test. (Note: If your reading is close to the upper range of the appropriate Orthophosphate test, you might want to consider completing the next higher range test for Total Phosphate because TP>OP.)

### **Orthophosphate Instructions:**

These instructions are for use with the HACH Orthophosphate test (Catalog No. 27120-00) for 25 mL sample, which is included in the Stream Survey Kit.

#### **CHECKLIST**

- 23 mL square mixing bottle
- PhosVer 3 phosphate powder pillows
- Color comparator (black box)
- Phosphate color disk (blue-violet)
- Glass test tubes
- Mirrors (inside color comparator) for low range
- Distilled water
- Watch or stopwatch
- Waste container
- Material Safety Data Sheets
- Testing Instructions
- Data Sheets

For greater accuracy and safety, it is recommended that this test be performed inside a well-ventilated setting.

#### ***Orthophosphate Low-range test (0-1 mg/L)***

1. Rinse and fill the square mixing bottle to the 20 mL mark with the water to be tested.
2. Open one PhosVer 3 Phosphate Powder Pillow and add its contents to the bottle. Gently swirl to mix. Allow at least two, but not more than ten minutes for full color development. (Note: If phosphate is present, a blue-violet color will form.)
3. Place the mirrors onto the shelf in the color comparator. Place the Phosphate (blue-violet) color disk into the comparator. (Note: The mirrors are used only during the Low-range tests.)
4. Fill one of the glass color viewing tubes to the top line with prepared sample. Place the tube on the right side of the comparator. (Note: Keep the rest of the prepared sample in the square mixing bottle until the test is complete. If the results are greater than 1 mg/L, you can use the same sample for the 0-5 mg/L test.)
5. Fill the other glass tube to the top line with untreated sample water and place it on the left side of the comparator.
6. Do not place caps on the tubes. Orient the comparator with the tube tops pointing to a window or light source. Rotate the disc until a color match is obtained. Divide the reading from the scale window by 50 to obtain the mg/L Orthophosphate.

### ***Orthophosphate Medium-range test (0-5 mg/L)***

#### **SHORTCUT:**

Take the sample left in the square mixing bottle from the Low-range test. Pour the sample to the 5 mL mark on the glass viewing tube and place it on the right side of the comparator. REMOVE THE MIRRORS and obtain a color match. Read the results and divide by 10 to obtain the mg/L Orthophosphate.

#### **REGULAR METHOD:**

1. Follow steps 1 and 2 of the Low-range test. Do not use the mirrors in the comparator for this test.
2. Fill one of the glass tubes to the bottom line with prepared sample (approximately 5 mL). Place the tube on the right side of the comparator.
3. Fill the other glass tube to the bottom line with untreated sample water and place it on the left side of the comparator.
4. Do not use the mirrors in the comparator. Holding the comparator up to a light source, view the tubes through the center windows. Rotate the disc until a color match is obtained. Divide the reading from the scale window by 10 to obtain the mg/L Orthophosphate.

### ***Orthophosphate High-range test (0-50 mg/L)***

1. Rinse the square mixing bottle and dropper with demineralized or distilled water. Add 2.0 mL of the water to be tested by twice filling the dropper to the 1.0 mL mark. (*This is a dilution of the sample.*)
2. Add demineralized or distilled water to the 20 mL mark of the mixing bottle. Swirl to mix.
3. Open one PhosVer 3 Phosphate Reagent Powder Pillow. Add the contents to the bottle. Gently swirl to mix. Allow at least two minutes, but not more than 10 minutes, for color development.
4. Fill one of the glass tubes to the bottom line with prepared sample (approximately 5 mL). Place the tube on the right side of the comparator.
5. Fill the other glass tube to the bottom line with untreated sample water and place it on the left side of the comparator.
6. Do not use the mirrors in the comparator. Holding the comparator up to a light source, view the tubes through the center windows. Rotate the disc until a color match is obtained. Read the mg/L Orthophosphate directly through the scale window.

## Total Phosphate Instructions:

These instructions are for use with the HACH Total Phosphate (Catalog No. 2250-01, Model PO-24) for 25 mL sample, which is included in the Stream Survey Kit.

### CHECKLIST

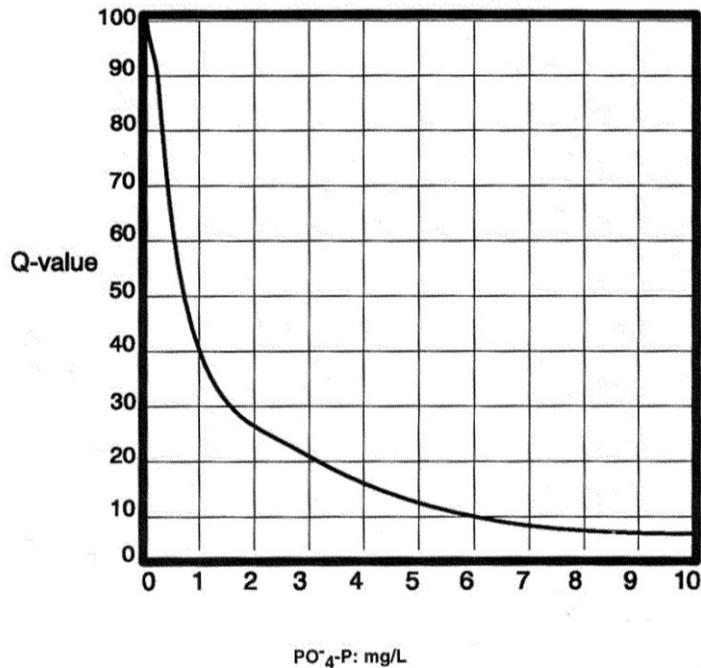
- 23 mL square mixing bottle
- Potassium persulfate powder pillows
- PhosVer 3 phosphate powder pillows
- Color comparator (black box)
- Phosphate color disk (blue-violet)
- Glass test tubes
- Mirrors (inside color comparator) for low range
- Distilled water
- 50 mL Erlenmeyer flask (for Total Phosphate)
- 5.25N sulfuric acid solution (for Total Phosphate)
- 5.0N sodium hydroxide (for Total Phosphate)
- Hot plate or other heating apparatus (for Total Phosphate)
- Tongs or oven mitt to remove Erlenmeyer flask from heating source
- Watch or stopwatch
- Waste container
- Material Safety Data Sheets
- Testing Instructions
- Data Sheets

1. Rinse and fill the square mixing bottle to the 20 mL mark with the water to be tested. Pour the sample into a clean 50 mL Erlenmeyer flask.
2. Open one Potassium Persulfate Powder Pillow and add its contents to the flask. Gently swirl to mix.
3. Add 2 mL of 5.25N Sulfuric Acid Solution to the sample by twice filling the dropper to the 1 mL mark and pouring the contents into the flask. Gently swirl to mix. (Note: Rinse thoroughly any surfaces, including your skin that may have contacted the acidic solution.)
4. Set up the boiling apparatus. (Note: A hot plate or camping stove is easier and more reliable than the fuel tablets provided with the kit.)
5. Boil the sample for 30 minutes, occasionally adding demineralized or distilled water to keep the liquid volume near 20 mL. Do not bring the volume above 20 mL. **Do not let it boil to dryness.**
6. Allow the liquid to cool.
7. Add 2 mL of 5.0N Sodium Hydroxide Solution by twice filling the dropper to the 1 mL mark and pouring the contents into the flask.
8. Return the sample to the square mixing bottle. Add demineralized or distilled water to return its volume to 20 mL.

9. Now perform the orthophosphate test of the appropriate range (pgs. 37-38) since all of the possible phosphate present in the sample is now in the “free” state. However, read the final result as mg/L Total Phosphate ( $\text{PO}_4$ ). Note: Total Phosphate should be greater than the Orthophosphate since Orthophosphate is a component of Total Phosphate. ( $\text{TP} > \text{OP}$ )

**TYPICAL RANGE FOR TOTAL PHOSPHATE = 0 to 0.85 mg/L**

### Total Phosphate Q-values



Note: if  $\text{PO}_4\text{-P} > 10.0$ ,  $Q = 2.0$

Total Phosphate (mg/L P)	Q-Value
0	99
0.05	98
0.1	97
0.2	95
0.3	90
0.4	78
0.5	60
0.78	50
1	39
1.5	30
2	26
3	21
4	16
5	12
6	10
7	8
8	7
9	6
10	5
>10	2