



# Indiana Water Operator Training Manual

## Lesson Eight – WT4 operators

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## **WT4 systems and operators**

A class WT4 (Water Treatment 4) system includes systems that meet the following:

- (A) Serve a population less than or equal to ten thousand (10,000) people
- (B) Acquire water from one (1) of the following:
  - (i) Surface water
  - (ii) Ground water under the direct influence of surface water

A grade WT4 operator is a certified operator qualified to operate a class WT1, WT2 and WT4 water treatment plant after having fulfilled the following requirements:

- (A) Possess a high school diploma or its equivalent
- (B) Meet the qualifications of the certification rule
- (C) Must be able to:
  - (i) maintain inventories
  - (ii) order supplies and equipment
  - (iii) interpret chemical and bacteriological sample reports
- (D) Attain the following acceptable work experience at a minimum:
  - (i) Two (2) years in the operation of a class WT4 water treatment plant
- (D) Attain the following acceptable work experience at a minimum:
  - (i) Two (2) years in the operation of a class WT4 water treatment plant
  - (ii) Successful completion of educational work at college level in:
    - (AA) engineering,
    - (BB) chemistry, or
    - (CC) science; related to water treatment may be substituted for work experience required according to item (i) at the ratio of four (4) semesters or six (6) quarters of schooling for a maximum substitution of one (1) year of experience

- (iii) Two (2) years in the operation of a class WT3 water treatment plant may substitute for a maximum of one (1) year of experience required according to item (i)

For persons employed by a DSL, WT3, WT4 or WT5 system, an Operator in Training (OIT) classification is available.

A grade Operator-in-Training (OIT) is available under the following guidelines:

- (1) To a person meeting the following:
  - (A) Currently employed at a public water system with facilities classified as a class WT 3, class WT 4 or class WT 5 water treatment plant or a DSL water distribution system
  - (B) has fulfilled the qualifications of the certification rule
- (2) In accordance with the following:
  - (A) Until the OIT meets the experience requirement needed for the classification of treatment plant or distribution system where the OIT is accumulating work experience
  - (B) Operating work must be accomplished under the supervision of a certified operator-in-responsible-charge who must verify to the Commissioner the satisfactory achievement of acceptable experience by the OIT
  - (C) An OIT may not:
    - (i) serve as a certified operator in responsible charge
    - (ii) transfer an OIT certification to a water treatment plant or distribution system with a public water system identification number (PWSID) different than the PWSID for which the certification was issued;
    - (iii) hold two (2) treatment plant or distribution system OIT certifications concurrently; or
    - (iv) renew the OIT certification

## **Surface water**

Surface waters are waters we see in lakes, streams, rivers and the like. Unlike ground water, surface water is not contained in an aquifer. A body of surface water is easily recharged by rain and the runoffs from nearby lands.

Surface waters are susceptible to pollution, temperature and pH changes. Water level changes can be dramatic. Surface waters often have higher turbidity than ground water. The water, however, is often has less hardness than ground water.

### Point source pollution

When a single source of pollution at a specific location can be identified, it is called point source pollution. Illegal drains from a factory discharging contaminants or an overflow pipe from a sewer system are examples of point source pollution.

Many communities across the United States are attempting to reduce or eliminate sewer overflows, especially during heavy rain events. These discharges pollute waterways and adversely affect animal life within these surface waters. The pollution also presents health threats to humans who may drink the water or enjoy it for recreational purposes.

Point sources of pollution often can be easily identified, but are very difficult (and usually expensive) to correct.

### Non-point source pollution

Non-point sources of pollution include farm runoff of chemicals such as fertilizers, animal wastes and pesticides. During periods of rain, these pollutants will drain from higher land levels into waterways and, also, adversely affect animal life within the surface water. High levels of pesticides and herbicides may also threaten humans and animals that may be exposed to the water.

## Surface water temperature

Surface water sources for drinking water may experience considerable changes in temperature during the year (especially in northern areas of the United States).

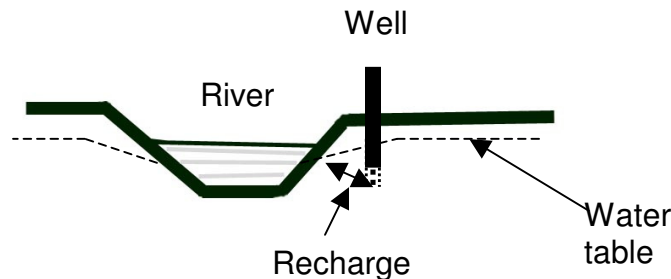
Colder water is denser than warmer water. When treating cold water, most processes slow down. Flocculation and settling go more slowly and chemical reactions take more time. Changes in source water temperature often require changes in the water treatment process that would not otherwise be required if the temperature remained constant.

### **Ground water under the direct influence of surface water**

The Safe Drinking Water Act definition of ground water under the direct influence of surface water is:

- Any water beneath the surface of the ground with:
  - Significant occurrence of insects or other macro-organisms, algae or large-diameter pathogens such as giardia lamblia, or
  - Significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions

In this drawing, the well near the river withdraws water from below the water table. Suction from the well may induce recharge from the river. In other words, the ground water and the surface water may “communicate.” The well may be under the direct influence of surface water.



If a water system’s wells are under the direct influence of surface water, the operational rules for that system may vary from other ground water systems. Please refer to lesson one of this manual for specific regulatory information concerning ground water systems under direct influence of surface water.

## **Coagulation and flocculation**

### Coagulation

Coagulation is the rapid mixing of coagulants with water in a tank or other structure to cause very small particles to join together (floc). Coagulants may include aluminum sulfate (alum), ferric chloride and synthetic polymers.

### Flocculation


Following the rapid mixing of coagulants to form floc, mixing is slowed to allow heavy floc to settle to the bottom of the tank and light floc to rise to the surface. The removal of the floc from the treated water may be continuous or performed as a batch process.

## Coagulant selection

pH is an important consideration in the selection of coagulants. pH stands for “potential of hydrogen” and is used as a measurement of the activity of hydrogen ions (H<sup>+</sup>) in a solution. A scale of 0 – 14 is used, where 7 is neutral, greater than (>) 7 is basic (alkaline) and less than (<) 7 is acidic (acid).

When an acid is put into water, the acid gives up H (hydrogen) to the water. When a base is poured into water, the base gives up OH (hydroxide) to the water.

Here are the approximant pHs of some common compounds:

|    |      |                          |   |         |
|----|------|--------------------------|---|---------|
| pH | 0    | Hydrochloric Acid        |  | Acid    |
|    | 2    | Lemon Juice              |   |         |
|    | 4    | Beer                     |   |         |
|    | 7    | Pure water               |   | Neutral |
|    | 11   | Ammonia                  |   |         |
|    | 12.4 | Lime (Calcium hydroxide) |   |         |
|    | 14   | Sodium Hydroxide         | Base  |         |

Aluminum sulfate (alum), ferric chloride and synthetic polymers are the most common coagulants used in water treatment.

- |   |                                  |                                  |
|---|----------------------------------|----------------------------------|
| <b>Alum</b>                                       | <b>Ferric chloride</b>           | <b>Synthetic polymers</b>        |
| ➤ 8 – 7.5 most effective pH range                 | ➤ Effective over a wide pH range | ➤ Effective over a wide pH range |
| ➤ Above 7.8 pH, becomes highly soluble            | ➤ Available as a liquid          | ➤ Many different types and forms |
| ➤ Will pass through filters                       | ➤ Very corrosive                 |                                  |
| ➤ May coagulate in clear well, or                 |                                  |                                  |
| ➤ Worse, may coagulate in the distribution system |                                  |                                  |

Select coagulants carefully. Water characteristics vary widely between water systems. Laboratory testing with product samples should be performed on your water (jar testing). Discuss treatment problems with multiple suppliers. Order small amounts of the product for an initial trial program before committing to full-scale implementation. Ask your IDEM inspector for advice before commencing a coagulant program.



Photo courtesy Velp Scientifica

A jar tester can be used to evaluate water treatment chemicals before adding them to the water system. Samples of water from the water system are placed in jars and different coagulants are mixed over a period of time and the results recorded. Once the best coagulant is selected, jar tests can be performed again to determine the best concentration.

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Congratulations. You have completed lesson eight of the Indiana Water Operator Training Manual.

To test your comprehension of the material included in lesson eight, a self-graded examination has been prepared for your use. The examination begins on the next page. There are 10 questions that will take a total of about 10-15 minutes to complete. Do not over analyze the questions. Just look for the best answer.

Good luck with the test. You will find the answers in Appendix G-8 of this manual.

There is a Microsoft PowerPoint® slideshow associated with these lessons. The slideshow is located on the compact disc included with this manual.

If you do not have the disc, or would like to view the slideshow on the Internet, you may find it at <http://www.Indianawateroperatortraining.org>.

# Indiana Water Operator Training

## Self-graded examination

### Lesson 8

Check one best answer per question

Question 1.

Characteristics of surface water include:

- A. Temperature changes
- B. pH changes
- C. Water level changes
- D. All of the above

Question 2.

Surface waters are subject to both point source and non-point source pollution.

- A. True
- B. False

Question 3.

Cold water usually speeds up chemical reactions.

- A. True
- B. False

Question 4.

Giardia lamblia is found in your well water. Your water source may be:

- A. Suffering from iron bacteria infestation
- B. Under the direct influence of surface water
- C. In need of chlorination
- D. Polluted with pesticides

Question 5.

Flocculation creates coagulants.

- A. True
- B. False

Question 6.

Which of the following is a coagulant?

- A. Aluminum sulfate (alum)
- B. Ferric chloride
- C. Neither A nor B above
- D. Both A and B above

Question 7.

pH refers to:

- A. Particles of Helium
- B. Pounds of Hydrogen
- C. Percentage of Hydrogen
- D. Potential of Hydrogen

Question 8.

Pure water has a neutral pH of:

- A. 0
- B. 5
- C. 7
- D. 14

MapFest



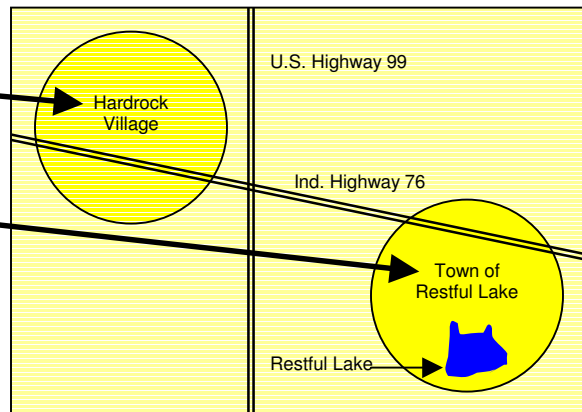
Question 9.

Your water system is here:

Your neighbor's water system is here:

The water characteristics of both water systems are probably:

- A. Very different
- B. Identical
- C. Indeterminable without testing
- D. None of the above



Question 9. map

Question 10.

This device is a jar tester.

What is it used for?

- A. Evaluating water treatment chemicals before adding them to the water system
- B. Biological assay
- C. Meeting IDEM laboratory control regulations
- D. Mixing chemicals at 25% concentration



Question 10. illustration