



Water System ID Number: IN\_\_\_\_\_

Operator Name: \_\_\_\_\_



Indiana Department of Environmental Management



Indiana Rural Water Association



American Water Works Association

# Indiana Water Operator Training Manual

Prepared for the Indiana Department of Environmental Management under contract by:  
Indiana Section American Water Works Association, Inc.  
Subcontractors – Indiana Rural Water Association, Inc., and Smith Group Consulting, LLC



# Indiana Water Operator Training Manual

## Introduction

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Indiana water system operators enjoy special responsibilities to their neighbors, families, friends and customers. These operators are, in the words of former Technical Secretary of the Indiana Stream Pollution Control Board, Oral Hert, “defenders of the public health and safety.” Safe drinking water is not just a convenience, it is a necessity.

Indiana public water systems are regulated by the Indiana Department of Environmental Management (IDEM). This training guide has been developed in cooperation with the United States Environmental Protection Agency (US EPA). The materials included in this training course are designed to assist “grandparented” and other small water system operators to understand and meet their important responsibilities in providing safe drinking water to their water system users.

This training guide contains useful information for all water system operators. Please keep this guide for future use and refer to it if you need help in understanding drinking water regulations, contacting state or federal environmental officials, or obtaining help from the government or professional organizations.

There are eight lessons in this guide. After the first tutorial, each class is designed to build upon information presented in previous lesson(s). You have been offered an opportunity to attend training classes on three or more of these lessons, depending upon the certification(s) that have been issued to you by IDEM. If you wish, you may attend additional classes or retake classes you have already attended, depending upon available space.

All training course materials will be made available to students on a computer CD-ROM disc and also will be accessible on the Internet.

Following each training class, there will be a self-graded test. You will be asked to turn in your self-graded test to your instructor. Your test results are not intended to be shared with other students or your employer. The test results will be used to evaluate training class effectiveness and identify students who may need additional assistance.

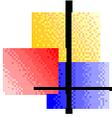
If your instructor believes you might benefit from additional assistance, you will be contacted privately. But you need not wait to be contacted if you believe you need some help. Just let your instructor know and arrangements will be made.

# Indiana

# Water Operator

# Training Manual

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# Indiana Water Operator Training Manual

## Lesson One – all operators

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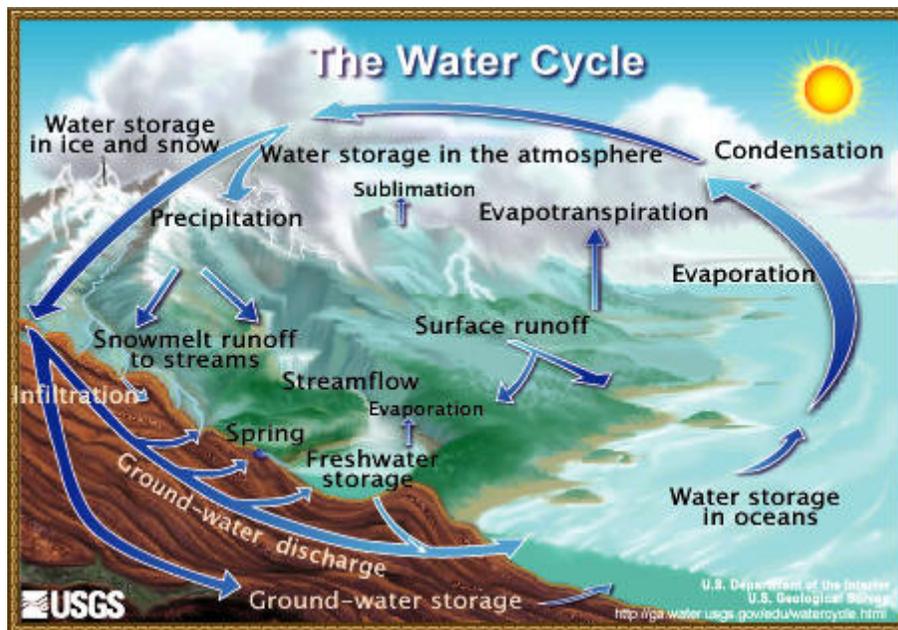
## Hydrological cycle

For the most part, the amount of water in the world has remained the same over the centuries. Water may change from ice to liquid, boil off to steam or evaporate into vapor, but the amount of water stays about the same in and above the earth. This means that the water we drink is recycled.

Nature does a pretty good job of cleaning up water through a process known as the hydrological cycle (also called the water cycle).

Human-made pollutants threaten water quality everywhere on the planet. Part of our job as water operators is to protect our water system from these pollutants by monitoring water quality and using best management practices to prevent the contamination of our drinking water supplies.

The following drawing illustrates the hydrological cycle:



Courtesy: U.S. Geological Survey

Please consult the glossary of this manual for information concerning some of the terms used in the drawing.

## **Overview of the Indiana Department of Environmental Management and the Drinking Water Branch**

The U.S. Congress is the authority for federal laws and regulations concerning the environment. The U.S. Environmental Protection Agency (EPA) implements Congress' laws.

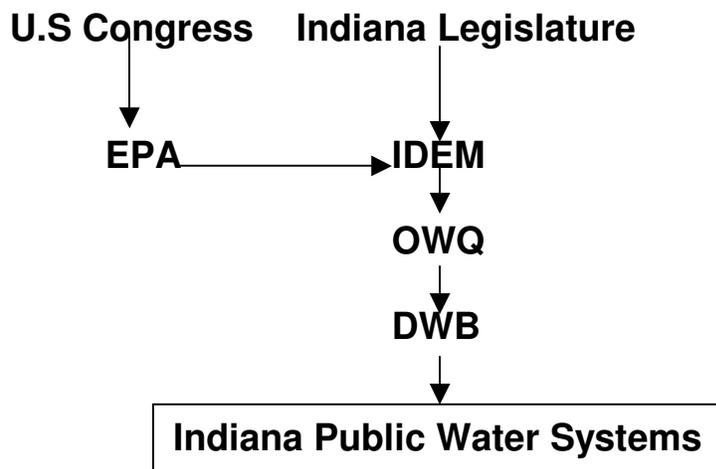
The Indiana Department of Environmental Management (IDEM) is responsible for implementing the U.S. Safe Drinking Water Act (SDWA) and the U.S. Clean Water Act (CWA) throughout Indiana.

The authority for these activities comes from the Indiana Legislature, which allows IDEM to work with the Indiana Stream Pollution Control Board to establish enforceable regulations concerning environmental matters.

IDEM's Office of Water Quality (OWQ) is responsible for maintaining clean air and water in Indiana. Several branches of OWQ work together to put the SDWA and the CWA into practice.

The Drinking Water Branch (DWB) has the responsibility to administer drinking water regulations. The four Sections of the branch (Compliance, Permits, Certification and Capacity Development, Field inspection and Ground Water) work together to meet branch goals.

The following diagram illustrates the above-described flow of responsibilities:



It is helpful to think of IDEM and the DWB as partners to Indiana public water systems in providing safe drinking water. DWB assists public water supply owners and operators to in complying with drinking water regulations. Assistance is provided through site visits, correspondence, telephone contact, educational presentations and materials and the small system laboratory assistance program.

## **Basic overview of regulations and operator responsibilities**

As a water system operator, you are responsible for providing safe drinking water to your community. That community can be very small or quite large. But regardless of its size, your community is made up of people you know and visitors who have been invited to stop by. Everyone who drinks water from your system should be assured that the water is safe.

You have chosen to be a water system operator, maybe because you like the work, or it is a necessary business obligation. Whatever the reason, you are in charge of and responsible for the operation of the water system under your control.

The U.S. Safe Drinking Water Act (SDWA) is the basic law that outlines your responsibilities. It was adopted in 1974 and is intended to protect drinking water quality throughout the United States, including above-ground (surface) water and under-ground (ground) water.

The SDWA authorizes the U.S. Environmental Protection Agency (EPA) to establish safe standards of purity. It requires owners and operators of public water systems to comply with primary (health-related) standards. EPA may allow any state to administer and enforce drinking water regulations if the state regulations are at least as stringent as federal regulations. This is called "primacy." Each state must apply for and receive primacy from EPA for each regulation adopted by the state.

Key elements of the SDWA include:

- Maximum Contaminant Level (MCL)
- Monitoring
- Reporting
- Public notification
- Public information
- Protection of water supply
- Types of water systems
- Operator certification
- Operator training

Indiana has been granted primacy by EPA to administer and enforce most of its drinking water regulations. Indiana's drinking water regulations are found in Indiana Administrative Code 327 IAC Article 8. These regulations have been adopted by the Indiana Stream Pollution Control Board, having been granted such authority by the Indiana General Assembly (state legislature).

The regulations have the force of law and are administered and enforced by the Indiana Department of Environmental Management (IDEM). Administration of the regulations is conducted through four sections of IDEM's Drinking Water Branch:

- Compliance
- Permits, Certification and Capacity
- Field Inspection
- Ground Water

You are probably reading this manual because you are affiliated with a public water system. Let us look at the definition of a public water system.

A public water system is a public water supply for the provision to the public of piped water for human consumption, if such system has at least:

- 15 service connections
- or regularly serves an average of at least 25 individuals daily at least sixty (60) days out of the year

There are several types of public water supplies:

Community system

- 15 or more residential service connections
- or 25 or more year-round residents served

Noncommunity system

- 15 or more non-residential service connections
- or 25 or more non-residents served 60 or more days per year

Nontransient Noncommunity

- Same 25 or more persons served 6 months or more per year

Transient Noncommunity

- Different 25 or more persons served 6 months or more per year

Many public water systems do not treat their water before distributing it to their customers. Most large water systems have some type of water treatment.

IDEM has determined that water distribution systems and water treatment plants should be classified, based upon a variety of criteria. This allows IDEM to determine what qualifications are required of those persons who operate these systems to help ensure that safe drinking water is provided to the customers of these systems.

There are three water distribution system classifications.

### DSS

Class DSS (distribution system small) includes systems that:

- (A) serve a population of less than three thousand three hundred one (3,301); and
- (B) have no components other than:
  - (i) pressure tanks; or
  - (ii) storage tanks

### DSM

Class DSM (distribution system medium) includes systems that meet one (1) of the following:

- (A) Serve a population greater than or equal to three thousand three hundred one (3,301) but less than or equal to ten thousand (10,000) people and have no mechanical means of movement of water other than one (1) of the following:
  - (i) Pressure tanks
  - (ii) Storage tanks
- (B) Consist of the following:
  - (i) Pump
  - (ii) Storage tanks
  - (iii) Booster pumps to storage tanks

### DSL

Class DSL (distribution system large) includes systems that meet one (1) of the following:

- (A) Serve a population greater than or equal to ten thousand one (10,001) people, or more
- (B) Consist of the following:
  - (i) Storage tanks
  - (ii) Booster pumps to the distribution system
  - (iii) Mechanical devices for movement of water beyond storage

There are six water treatment system classifications.

### WT1

Class WT1 (water treatment 1) includes systems that meet the following:

- (A) Serve a population less than or equal to five hundred (500) people
- (B) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (C) Have one (1) of the following:
  - (i) Ion exchange softening process for cation removal
  - (ii) Inline filtration device with no chemical treatment

### WT2

Class WT2 (water treatment 2) includes systems with no population limitations that meet the following:

- (A) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (B) Utilize chemical feed to achieve one (1) of the following:
  - (i) Disinfection
  - (ii) Fluoride standardization, or
  - (iii) Water stabilization

### WT3

Class WT3 (water treatment 3) includes systems that meet the following:

- (A) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (B) Utilize chemical feed
- (C) Have one (1) of the following:
  - (i) Pressure or gravity filtration
  - (ii) Ion exchange processes if the population served is five hundred one (501) or greater
  - (iii) Lime soda
  - (iv) Reverse osmosis

#### WT4

Class WT4 (water treatment 4) 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

#### WT5

Class WT5 (water treatment 5) includes systems that meet the following:

- (A) Serve a population of ten thousand one (10,001) or more people
- (B) Acquire water from one (1) of the following:
  - (i) Surface water
  - (ii) Ground water under the direct influence of surface water

#### WT6

Class WT6 (water treatment 6) includes systems that utilize newly emerging treatment technology not commonly in use for drinking water treatment in Indiana, as determined by the Commissioner of IDEM.

### **Audit your system classification**

Now that you understand how public water supplies, distribution and treatment systems are classified, it is a good time to determine if your supply and/or system are classified correctly.

Various documents you have received from IDEM will have these classifications referenced. Do you believe, using the information contained in the previous pages of this manual, that your supply and system are classified correctly?

If your answer to the above question is no, or you are unable to determine your classification(s) from IDEM documents, you should contact IDEM to discuss the matter.

The Permits, Certification and Capacity section of IDEM's Drinking Water Branch can help you with this issue. You can telephone them at 317-308-3299.

### **Operator and system certification**

IDEM regulations require that public water systems have someone in charge. That person is known as the "operator in responsible charge."

The operator in responsible charge is a person designated by the owner or governing body of a water treatment plant or water distribution system to be the certified operator who has complete responsibility for the proper operation of a water treatment plant or water distribution system. That operator makes decisions regarding the daily operational activities of a public water system treatment plant or distribution system that will directly impact the quality or quantity of drinking water from community public water supply systems and nontransient noncommunity public water supply systems.

Operators are required to possess a variety of skills and experience to become certified. Generally speaking, the types of skills and experience required correspond to the complexity of the water system being operated. All operators, however, must have the following minimum qualifications to operate a system:

- (A) make simple computations with fractions and decimals
- (B) read a linear scale
- (C) calculate volumes of simple shapes
- (D) make simple computations of multiplication and division
- (E) keep records
- (F) read and write the English language to the extent of interpreting service manuals and work orders and submitting written reports
- (G) understand basic principles of sanitation
- (H) understand basic principles of science

With the exception of an operator-in-training, all operators must have experience acceptable to the Commissioner of IDEM in the field of water treatment or water distribution that:

- (A) demonstrates the examination applicant's technical knowledge
- (B) can be verified based on information from available sources, primarily the applicant's water treatment plant or water distribution system employer
- (C) is the result of satisfactory accomplishment of work in accordance with the following:
  - (i) measured from the date of employment of the applicant to the date of the next scheduled examination
  - (ii) received under the supervision of a certified operator qualified to operate the same classification of treatment plant or distribution system as that of the applicant's certification application

A grandparented operator is an employee of a water system that was not required to have a certified operator prior to the adoption of the certification rule (August 9, 2000) and who has been issued an operator's certification appropriate for the class of system operated by the employee.

A grandparented operator may not use his/her certification to work at any other system. The grandparented certification becomes invalid if the water system changes significantly and requires greater technical expertise to operate.

Some operators of one grade may operate a system of a different grade.

- DSS operates only DSS systems
- DSM operates DSS and DSM systems
- DSL operates DSS, DSM and DSL systems
- WT1 operates only WT1 systems
- WT2 operates WT1 and WT2 systems
- WT3 operates WT1, WT2 and WT3 systems
- WT4 operates WT1, WT2 and WT4 systems

- WT5 operates WT1, WT2, WT4 and WT5 systems
- WT6 operates only WT6 systems
- Grandparented operates only the system at which the operator was grandparented

Operators are required to complete continuing education courses in order to maintain their certifications. IDEM, professional organizations and private parties offer training opportunities. It is the responsibility of operators to be sure that these training courses have received prior approval by IDEM for continuing education credit.

IDEM's continuing education requirements are shown below.

Grade	Contact hours over 3-year period
DSS	10
DSM	15
DSL	15
WT1	10
WT2	15
WT3	25
WT4	30
WT5	30
WT6	30
 OIT	 Contact hours shall match those required for the classification where operator is in training; certification card not renewable
 Grandparented	 (A) fulfill the continuing education requirements for the grade of operator certification that has been conferred through grandparenting (B) successfully complete an operator training course specified by the Commissioner

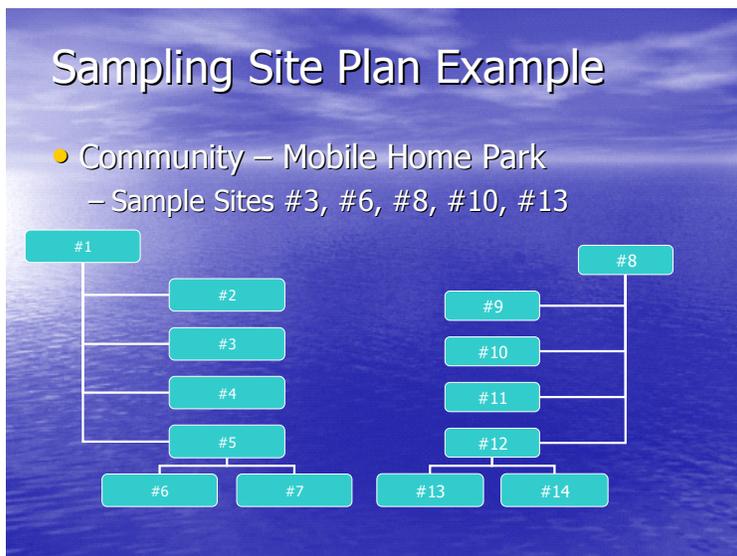
## Basic water sampling

An important element of operating a public water system is sampling. Most sampling is routine and performed to verify that everything is OK. Occasionally, an analysis of a water sample indicates a problem. Since the possibility of a sampling or laboratory error always exists, a repeat sample should be obtained as soon as possible following notification of the laboratory testing result on the first sample.

All water systems conduct bacteriological sampling by collecting and testing for total coliform. The minimum collection schedule for Indiana water systems is as follows:

Community	Monthly
Noncommunity	Quarterly

When collecting samples, be sure to follow a sampling site plan. Sampling site plans are drawings that show where water system samples are withdrawn. The plan can be hand drawn or notations made on a map.



This is an example of a sampling site plan – of the 14 sites, 5 have been chosen which are representative of the entire distribution system. Samples are to be rotated on a monthly basis.

After submitting the plan to IDEM, the field inspector reviews it and, if approved, a letter is sent to the system.

The plan may be updated at any time by submitting the changes to IDEM.

Coliforms are bacteria and are naturally present in the environment. Fecal coliforms and E. coli come from human and animal fecal waste. Total Coliform are used as in indicator that other potentially harmful bacteria may be present.

Collecting water samples for coliforms testing is easy if you follow the procedures. If you are not careful, however, you can contaminate the sample, which can lead to unnecessary headaches.

Before you start the sampling process, fill out the bottle label and tag and complete the laboratory form. Do not rinse out the bottle before sampling. Wipe or spray the faucet nozzle with bleach (do not flame or use a torch).

The following steps will help you collect water samples:

- Turn on the water (cold, not hot) and let it run fully for 5 or more minutes
- Wash your hands
- Hold the bottle near the bottom so your fingers do not taint the sample.



- Reduce the flow to 1/8 inch and run for another 5 or more minutes
- Remove the cap and keep it level
- Do not put the cap down anywhere
- Just hold the cap aside making sure you do not get it wet or dirty



- Place the open bottle under the flow and fill to about 1/4 inch from top
- Do not allow the faucet to touch the bottle
- Remove the bottle from the water stream and screw on the lid
- Do not touch the inside of the cap
- Do not over-tighten the cap

After you finish the sampling process:

- Set bottle aside somewhere clean
- Verify that the label and tag are correct and complete
- Make sure the chain-of-custody form is complete and agrees with the other information you have provided
- Preserve the sample

To preserve the sample, pack the sample and the forms as instructed by the laboratory. The temperature of the sample must be kept between 39° and 50° F (4-10° C). Pack it in ice and take it to the laboratory immediately (if nearby), or pack it in blue ice and overnight ship or courier deliver. The sample must reach laboratory within 30 hours of collection.

This is the water system report form that is completed by the water system operator.

The instructions for completing the form are on the next pages of this manual.

PUBLIC WATER SYSTEM REPORT	
LAST NAME ADDRESS CITY, STATE, ZIP (AREA CODE) TELEPHONE NUMBER CERTIFIED LAD ID NUMBER	Sample Number _____ Date Received _____ Time Received _____ Date Reported _____
<small>Samples will not be analyzed if form is not complete and block ink. Laboratory - please send a copy to:</small> _____ _____ _____ IN _____ _____	<b>ANALYSIS DATA - FOR LAB USE ONLY</b> <b>TEST: TOTAL COLIFORM</b> METHOD: <input type="checkbox"/> MPN <input type="checkbox"/> MPN <input type="checkbox"/> LST P/A <input type="checkbox"/> M/M P/A <input type="checkbox"/> M/MQ1 RESULTS: _____ Most Probable Number <input type="checkbox"/> PRESENT <input type="checkbox"/> ABSENT _____ Analyzed: _____ Date: _____ Time: _____
<b>TO BE COMPLETED BY PUBLIC WATER SYSTEM</b> PWS ID: _____ County: _____ Date: _____ Time: _____ Location Code: _____ Sampling Location Address: _____ Obsolete Residential Sampling Address: _____ mpt Printed Name & Initial of Sample Collector: _____	<b>TEST: <input type="checkbox"/> FBICAL COLIFORM <input type="checkbox"/> F COLI</b> METHOD: <input type="checkbox"/> MPN <input type="checkbox"/> MPN <input type="checkbox"/> LST P/A <input type="checkbox"/> M/M P/A <input type="checkbox"/> M/MQ1 RESULTS: _____ Most Probable Number <input type="checkbox"/> PRESENT <input type="checkbox"/> ABSENT _____ Analyzed: _____ Date: _____ Time: _____ <b>HETEROTROPHIC PLATE COUNT</b> 7d. Inc. _____ 10 Inc. _____ <small>If MPN or M/MQ1 is checked, the result is a statistical determination of the most probable number per 100ml. If MP is checked, the result is organisms per 100ml. If P/A is checked, the result is present or absent.</small>
<b>SAMPLETYPE (check appropriate square)</b> <input type="checkbox"/> D-Distribution <input type="checkbox"/> C-Repeat <input type="checkbox"/> O-Other Date Original Sample Collected (if sample is a repeat): _____ SUBMIT NO: _____ PWS Name of Certified Operator: _____ Signature of Certified Operator: _____	<b>REPORT OF SAMPLES</b> <input type="checkbox"/> SUBMIT REPEAT SAMPLES as required under 327 IAC 8-2-8.1 <input type="checkbox"/> PLEASE SUBMIT ANOTHER SAMPLE. TEST NOT VALID BECAUSE: <input type="checkbox"/> Locking in time (more than 48 hours) <input type="checkbox"/> Invalid no. collection date and/or time. <input type="checkbox"/> Sample breaker broken in shipment, insufficient volume. <input type="checkbox"/> Invalid chain of custody. <input type="checkbox"/> Other _____ Approved by: _____ Reviewed by: _____

**DIRECTIONS FOR FILLING OUT PUBLIC WATER SYSTEM  
REPORT  
STATE FORM 39231R**

- A. Print clearly, **filling in ALL information in the left hand column** of the bacteriological report form.
- B. Return the completed form with your sample to the laboratory within 30 hours of collection. Samples over 48 hours old will not be analyzed.
- C. Fill in the following information:
1. **NAME / ADDRESS** -- Where sample result should be sent.
  2. **ORGANIZATION PHONE NUMBER** -- Including area code of the Public Water System.
  3. **PWS ID (Public Water Supply Identification)** --This is a unique number assigned your water supply for identification purposes. It is **required** for analysis to be performed.
  4. **COUNTY** – County where facility is located.
  5. **DATE OF SAMPLE** --Use month, day and year sample was collected.
  6. **TIME OF SAMPLE** --Indicate the time of day that the sample was collected using the 2400 hour terminology.
  7. **LOCATION CODE AND SAMPLING ADDRESS** --A system representing the sampling location is required under 327 IAC 8-2-8(a). Each sampling location can be assigned a unique 4-digit number (location code) by the water operator.
    - i. e.g.     Sampling address / water tap JOHN DOE RESIDENCE / kitchen sink Location Code 0 0 0 1
    1. John Doe's residence will have the identifying number 0001.
  8. **CHLORINE RESIDUAL**--Indicate chlorine residual.
  9. **PRINTED NAME & INITIAL OF SAMPLE COLLECTOR** – Person who collected the sample.
  10. **SAMPLE TYPE & DATE ORIGINAL SAMPLE COLLECTED** --Check appropriate square to indicate type of sample: “**distribution**”, “**repeat**”, or “**other**”. If the sample type is a “repeat” sample, indicate the date when the original sample was collected. If the sample type is “other”, see remarks #11.
  11. **REMARKS** --Indicate type of sample, i.e., raw water, new main, etc.
  12. **PRINTED NAME & INITIAL OF CERTIFIED OPERATOR** – A Certified Operator is required under 327 IAC 8-12 for Nontransient Noncommunity & Community Water Systems.
- D. ALL SAMPLES MUST BE RECEIVED IN THE LABORATORY BY 3:00 PM.
- E. USE THE ENCLOSED BOTTLE. SAMPLES SUBMITTED IN OTHER CONTAINERS WILL **NOT** BE ANALYZED. THIS BOTTLE CONTAINS SODIUM THIOSULFATE WHICH MAY APPEAR AS DROPLETS OF A WHITE POWDER. DO NOT RINSE THIS OUT. FILL EXACTLY TO THE 100 ML LINE.

## EXPLANATION OF SAMPLE STATUS

ANOTHER SAMPLE MUST BE SUBMITTED IF ANY OF THE FOLLOWING ARE INDICATED ON THE REVERSE:

1. **TOO LONG IN TRANSIT:** Sample received more than 48 hours after collection; NOTE: RESULTS OF SAMPLES RECEIVED MORE THAN 30 HOURS AFTER COLLECTION MAY BE INVALID.
2. **INVALID OR NO COLLECTION DATE AND/OR TIME:** Samples will not be analyzed without a date or time. Samples received in lab with date of collection later than time received has an invalid date.
3. **SAMPLE LEAKED OR BROKEN IN SHIPMENT, INSUFFICIENT VOLUME:** Sample container was damaged or leaked in transit resulting in insufficient sample volume. Test procedure requires 100 ml.
4. **RESIDUAL CHLORINE:** The presence of chlorine in the sample interferes with testing, invalidating the sample.
5. **HIGH BACKGROUND COUNT:** Sample contained a large number of bacteria, which inhibits an accurate determination of coliform bacteria.

Samples need to be representative of the water system. You should avoid:

- Fire hydrants
- Yard hydrants
- Mop sinks
- Drinking fountains
- Hose bibs

Be sure to remove:

- Strainers
- Aerators
- Hoses

It is the water system operator's responsibility to make sure that copies of sampling reports are sent to IDEM.

## Other Monitoring Requirements

Coliform and Nitrate monitoring is required for all water systems. In addition, all community and nontransient noncommunity public water systems are required to monitor for three (3) chemical contaminant groups.

Monitoring is required for the following chemical contaminant groups: inorganic chemicals (IOCs), which often appear as naturally occurring contaminants in source water, volatile organic compounds (VOCs) such as industrial solvents, and synthetic organic compounds (SOCs). Common examples of SOCs include pesticides and herbicides.

All community and nontransient noncommunity public water systems are also required to sample for lead and copper.

If your system chlorinates, you need to monitor free and total chlorine in the distribution system.

More information about monitoring requirements will be presented in some of the other lessons of this manual.

### **Small system laboratory assistance program**

The small system laboratory assistance program (SSLAP) is a free service of IDEM and the Indiana State Board of Health (ISBH) to provide sampling assistance to public water systems serving population less than 100 people for coliform bacteria and nitrate contaminants. Free sampling bottles are provided as part of the program.

If you sample for other contaminants, you will need to continue doing so, even if you decide to participate in the SSLAP.

If you would like more information on the program, please contact DWB's Sandra DeCastro, 317-308-3295, or David Forsee, 317-308-3288. You can also telephone 800-451-6027 toll-free and ask to speak with either of the above persons.

## Certified laboratories

ISBH certifies laboratories under the Safe Drinking Water Act. Please refer to Appendix D of this manual for assistance in locating certified laboratories.

## **Positive total coliform sample procedures**

If you receive a report of a positive coliform test result (unsatisfactory - test shows presence of coliform), there are several steps you should take:

1. Notify the compliance section of IDEM by telephoning them at 317-308-3282 to make sure they are aware of the situation and to request guidance. For after-hours assistance, contact the IDEM Environmental Helpline at 800-451-6027.
2. Contact the laboratory that conducted the test to discuss the laboratory report and to alert them that you will be sending them additional samples for testing.
3. If your system's routine test is unsatisfactory, you will be required to collect a set of three repeat samples (if more than one required distribution sample is taken per month) or four repeat samples (if only one required distribution sample is taken per month) and have them analyzed.

At least one of the repeat samples must be collected from the same sample tap as the original unsatisfactory sample, one collected within five service connections upstream and one within five service connections downstream. If a fourth repeat sample is required, then it may be collected anywhere in the distribution system.

All repeat samples **must** be collected on the same day, and within **24 hours** of being notified of the unsatisfactory test result. Note: IDEM may extend the collection period to a maximum of 48 hours, if there is a problem beyond the control of the water system in collecting the samples within 24 hours.

Repeat samples are to be collected and tested until all repeat samples are satisfactory.

4. If any repeat sample is unsatisfactory, your customers (users of the water system) must be notified. See the public notification section of this lesson for public notification procedures.
5. After all repeat sampling tests are satisfactory, all public water systems are required to collect five more distribution samples the month after any unsatisfactory total coliform sample.

Example: If you collect a routine sample on July 10 and it is total coliform positive, you will collect three or four repeat samples as soon as you are notified of the positive sample and you will also collect five routine samples in August.

In the above example, the collection of the additional samples is basically a double check to ensure that the problem has been resolved. You should collect two of the samples one week and the other three samples the following week.

6. As previously mentioned, it is the water system operator's responsibility to make sure that copies of sampling reports are sent to IDEM.

## **Well disinfection**

Sometimes coliform bacteria in a well may result in unsatisfactory sampling results. Disinfecting your well may assist in resolving bacteriological issues. Your IDEM field inspector can discuss this matter with you. Please see Appendix A of this manual if you need help in contacting your inspector.

### When to disinfect

- When coliform bacteria are present
- When water taste or odor change
- After casing or pump repairs
- After installing new plumbing fixtures

- After flooding of the well
- During startup of seasonal wells
- As part of annual maintenance

### How to disinfect

Here are a few steps that can be used to disinfect a well:

1. Turn off the electrical supply
2. Separate the well from the water system with the isolation valves
3. Remove well cap/seal & move wiring out of the way
4. Mix 1/2 of a gallon of household bleach with 3 gallons of water (good for a 4" well, 100 feet deep)
5. Pour mixture into well
6. Turn well on and recirculate water with a garden hose for about two hours after you begin to smell chlorine from the hose
7. If the water runs red (from iron), discard the water somewhere safe (do not run heavily-chlorinated water into your septic system)
8. With the water still recirculating, open a few faucets, hose bibs, etc., until chlorine is detected (use faucets farthest away from the well)
9. Turn off well, recap and let sit for about eight hours
10. Turn on well and run to flush remaining chlorine from the system, running hose somewhere safe to discard the chlorinated water

### Special considerations

- Do not sample for coliform unless total chlorine is absent
- If you cannot sample for chlorine, wait a few days after all chlorine smell is gone before drawing coliform samples
- You may have to repeat the disinfection process one or more times to completely remove all bacteria
- Do not bring heavily chlorinated water into a water softener (too much chlorine can cause damage to the softener)  
Disinfect softeners separately following manufacturer's instructions (usually pouring a 1/2 cup of bleach into the brine and regenerating)

## **Public notification**

Occasionally during the operation of a water system, a violation of IDEM's rules may occur. If that happens, the users of the water system must be notified. This process is called "public notification."

The purpose of public notification is to inform your users of a problem with the drinking water that is being addressed. Public notification acts as a precautionary measure for your users and you.

The following information is intended as a guideline and may not cover all situations. Please contact IDEM immediately if you have any questions about public notification for your system.

### Immediate notification – all water systems

This must take place when a violation of the Maximum Contaminant Level (MCL) for total Coliforms when fecal Coliform or E. coli are present, or the failure to test for fecal Coliforms after the initial total Coliform sample or repeat samples test positive or, there is a nitrate, nitrite, or total nitrate and nitrite MCL violation, and the system fails to take a confirmation sample within 24 hours after the system receives the first sample showing an exceedance of the MCL.

An MCL is the highest level of a contaminant that is allowed in drinking water. MCLs are set as close to maximum contaminant level goals as feasible, using the best available treatment technology and taking cost into consideration. Maximum contaminant levels are enforceable standards.

Additional circumstances requiring immediate notification are waterborne disease outbreaks or other waterborne emergencies, and other violations or situations with significant potential to have serious adverse effects on human health with short-term exposure.

## Annual notification – community water systems

Annual notifications are placed in community water systems' annual water quality report (consumer confidence report). These notifications include minor monitoring violations, failure to comply with a testing procedure, operation of the water system under a variance or exemption or exceedance of the fluoride secondary maximum contaminant level (SMCL).

Public notifications must contain the following information:

1. A description of the violation that occurred, including the potential health effects
2. Identification of the population at risk and if alternate water supplies need to be used
3. What the water system is doing to correct the problem
4. Actions consumers can take
5. When the violation occurred and when the system expects it to be resolved
6. How to contact the water system for more information
7. Language encouraging broader distribution of the notice

On the next pages are examples of public notifications that you can use for your water system should the need arise.

# Non-emergency notification

## **IMPORTANT INFORMATION ABOUT YOUR DRINKING WATER** **Tests Show Coliform Bacteria in Yarmouth's Public Water System**

Our water system recently violated a drinking water standard. Although this is not an emergency, as our customers, you have a right to know what happened, what you should do, and what we are doing to correct this situation.

We routinely monitor for the presence of drinking water contaminants. We took 55 water quality samples for coliform bacteria during November. Ten samples, or eighteen point two ( 18.2% ) of those samples showed the presence of coliform bacteria. The standard is that no more than five ( 5 ) samples per one-hundred ( 100 ) samples per month or five percent (5%) of our samples may do so.

### **What should I do?**

- **You do not need to boil your water or take other corrective actions.** However, if you have specific health concerns, consult your doctor.

People with severely compromised immune systems, infants, and some elderly may be at increased risk. These people should seek advice about drinking water from their health care providers. General guidelines on ways to lessen the risk of infection by microbes are available from EPA's Safe Drinking Water Hotline at 1 (800) 426-4791.

### **What does this mean?**

This is not an emergency. If it had been you would have been notified immediately. Total coliform bacteria are generally not harmful themselves. *Coliforms are bacteria which are naturally present in the environment and are used as an indicator that other, potentially-harmful, bacteria may be present. Coliforms were found in more samples than allowed and this was a warning of potential problems.*

Usually, coliforms are a sign that there could be a problem with the treatment or distribution system (pipes). Whenever we detect coliform bacteria in any sample, we do follow-up testing to see if other bacteria of greater concern, such as fecal coliform or *E. coli*, are present. **We did not find any of these bacteria in our subsequent testing, and further testing shows that this problem has been resolved.**

### **What happened? What is being done?**

As part of an evaluation, we have stopped adding a chemical, Sodium Hexametaphosphate, to the water supply. The goal is to reduce the amount of chemicals added to your water. We think that's a good thing. The early results of the evaluation are promising. However, apparently a short term side effect can be water discoloration and cultivation of some generally non harmful bacteria. The positive test results were concentrated in the vicinity of the German Hill storage tank. The Water Division took immediate action to protect the water distribution system. We destroyed the bacteria by injecting disinfectant into the German Hill tank.

We will continue the evaluation to reduce the amount of chemicals added to your water. Additionally, we will continue to employ the "Best Available Technology Treatment Techniques" to reduce the bacteria in the water supply. We take this matter very seriously, and we will endeavor to provide you the best quality water.

For more information, please contact Mr. Dan Mills at 508.771.7921 or at 99 Buck Island Road West Yarmouth, Ma. 02673.

*Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.*

This notice is being sent to you by the  
Yarmouth Water Department

PWS ID#:  
4351000

Date distributed:  
XXXXXX

This type of notice should be issued as soon as possible, but not later than 24-hours after the violation by hand delivering it to your system users or posting it in conspicuous locations within the area served by the system. Redelivery and/or posting must be accomplished every three months for as long as the violation continues.

## Emergency notification

<b>DRINKING WATER WARNING</b>								
<p>_____ [system] Water is Contaminated with Fecal Coliform/<i>E. coli</i> Bacteria</p> <p><b>BOIL YOUR WATER BEFORE USING</b></p> <p>Fecal coliform [or <i>E. coli</i>] bacteria were found in the water supply on _____ [date analysis completed]. These bacteria can make you sick, and are a particular concern for people with weakened immune systems.</p> <p><b>What should I do?</b></p> <ul style="list-style-type: none"> <li>• <b>DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST.</b> Bring all water to a boil, let it boil for one minute, and let it cool before using, or use bottled water. Boiled or bottled water should be used for drinking, making ice, brushing teeth, washing dishes, and food preparation <b>until further notice</b>. Boiling kills bacteria and other organisms in the water.</li> <li>• <b>Fecal coliforms and <i>E. coli</i> are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, some of the elderly, and people with severely compromised immune systems.</b></li> <li>• The symptoms above are not caused only by organisms in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice about drinking water from their health care providers.</li> </ul> <p><b>What happened? What is being done? When will the problem be corrected?</b> Bacterial contamination can occur when increased run-off enters the drinking water source (for example, following heavy rains). It can also happen due to a break in the distribution system (pipes) or a failure in the water treatment process.</p> <p>[Water system to describe corrective actions being taken.] Upon the State's approval, we will inform you when tests show no bacteria and you no longer need to boil your water. We anticipate resolving the problem within [estimated time frame].</p> <p>General guidelines on ways to lessen the risk of infection by microbes are available from the EPA Safe Drinking Water Hotline at 1(800) 426-4791.</p> <p><b>Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.</b></p> <p>For more information, please contact:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Responsible Person</td> <td style="width: 33%;">System Name</td> <td style="width: 33%;">System Address (Street)</td> </tr> <tr> <td>Phone Number</td> <td>System PWSID#</td> <td>System Address (City,State,Zip)</td> </tr> </table> <p>Violation Awareness Date: _____</p> <p>Date Notice Distributed: _____ Method of Distribution _____</p> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <p style="text-align: center;"><b>Public Notification Certification</b></p> <p>The public water system named above hereby affirms that public notification has been provided to its consumers in accordance with all delivery, content, format, and deadline requirements specified in 15A NCAC 18C .1523.</p> <p>Owner/Operator: _____</p> <p style="text-align: center;">(Signature) (Print Name) (Date)</p> </div>			Responsible Person	System Name	System Address (Street)	Phone Number	System PWSID#	System Address (City,State,Zip)
Responsible Person	System Name	System Address (Street)						
Phone Number	System PWSID#	System Address (City,State,Zip)						

This type of notice should be issued as soon as possible, but not later than 24-hours after the violation by hand delivering it to your system users or posting it in conspicuous locations within the area served by the system. Redelivery and/or posting must be accomplished every three months for as long as the violation continues.

All public notices must be certified to IDEM within 10 days. Do not wait to notify IDEM through the certification process. IDEM should be notified as soon as possible by telephone or fax if there is a problem with your system's drinking water.

Example of IDEM certification

<b>Certification for Public Notice</b>	
Public Water System Name:	_____
Public Water System Identification Number:	_____
For Violation:	_____ (describe violation or situation)
Occurring on:	_____ (date)
<i>The public water system indicated above hereby affirms that public notice has been provided to consumers in accordance with the delivery, content, and format requirements and deadlines in 327 IAC 8-2.1-7.</i>	
• Consultation with primacy agency (if required) on	_____ (date)
• Notice distributed by _____ (method) on _____ (date)	_____ (date)
• Notice distributed by (if needed) _____ (method) on _____ (date)	_____ (date)
• Content – required elements.	
Signature of owner or operator _____	Date _____

More information concerning public notification and IDEM's requirements may be found in Appendix E of this manual.

If you issue a public notice advisory, do not forget to cancel it when the problem is resolved. Distribute the cancellation in the same manner and to the same parties as you distributed the original notice.

## **Wellhead protection**

As previously mentioned, an important responsibility of a water operator is to protect the operator's water supply from pollution.

Wellhead protection is a program used by ground water supplies to help protect their drinking water from known and potential sources of contaminants.

Wellhead protection is mandatory for community water systems and, at the time of the writing of this manual, voluntary for other water systems.

A wellhead protection program identifies the flow of ground water toward a system's well(s) and predicts how long it may take a particle of water to travel a given distance over a period of time (usually one, five or ten years).

Armed with the knowledge of how ground water flows in the area of a well, a water system can identify potential and actual sources of contaminants and manage these sources to help prevent pollution of the well. Security and emergency response are important elements of wellhead protection.

Wellhead protection is a public process that encourages participation by the water system, its users, local businesses and emergency responders.

For a more detailed discussion of wellhead protection, please refer to lesson five of this manual.

## State contacts

IDEM is the main agency to contact for information relating to your water system. The people at IDEM are your partners in providing safe drinking water. Do not hesitate to contact IDEM with whatever questions you may have. Contacting IDEM too frequently will not likely get you into trouble, but **not** contacting IDEM when you should, can lead to problems.

Always contact IDEM if you issue a public notification of a system violation. If you see a problem developing, call IDEM. The people there may be able to give you some advice.

The main telephone number for IDEM's Drinking Water Branch, Field Inspection Section, is 317-232-8608. IDEM's toll free number is 800-451-6027. To report environmental emergencies, call 888-233-7745. IDEM's Website is <http://www.in.gov/idem>.

Appendix A2 of this manual provides more contact information for the Drinking Water Branch and its operating sections.

Here is some contact information for other state agencies:

Indiana Department of Homeland Security  
<http://www.in.gov/dhs>  
Emergency response 317-232-3834

Indiana Geological Survey  
<http://adamite.igs.indiana.edu/>  
812-855-7630

Indiana Department of Natural Resources  
<http://www.in.gov/dnr>  
317-232-4160 or 877-928-3755

Indiana National Guard  
<http://www.inarng.org/>  
317-247-3300

Indiana Department of Transportation  
<http://www.in.gov/dot>  
317-232-5533

Indiana State Police  
<http://www.in.gov/isp/>  
317-899-8577 or 800-582-8440

## Where to get help

So you need help with a problem. The first place to start may be with the IDEM inspector assigned to your area. A map of the state with the various inspector contact information may be found in Appendix A1 of this manual. IDEM inspectors love challenges. Call them if you need some help.

The U.S. EPA is a great source of drinking water information. Appendix A4 provides several EPA contacts.

Many state and national organizations are dedicated to assisting waterworks operators. Contact information for these organizations may be found in Appendix A3.

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

To test your comprehension of the material included in lesson one, 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-1 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 1

Check one best answer per question

Question 1.

The Safe Drinking Water Act was adopted to protect:

- A. Ground water drinking water
- B. Surface drinking water
- C. Both ground and surface drinking water
- D. Bottled drinking water

Question 2.

EPA allows the State of Indiana to administer and enforce drinking water regulations because:

- A. Indiana has applied for Primacy from EPA
- B. Indiana has been granted Primacy by EPA
- C. Indiana's regulations are at least as stringent as federal regulations
- D. All of the above

Question 3.

A factory provides drinking water from its well for 35 employees Monday through Friday most weeks of the year. What kind of public water supply is it?

- A. Community
- B. Noncommunity
- C. Nontransient Noncommunity
- D. None of the above

Question 4.

A community of 1,500 people pumps water directly from 2 wells into a 25,000-gallon standpipe. How would IDEM classify the distribution system?

- A. DSS
- B. DSM
- C. DSL
- D. WT-6

Question 5.

The community above (in Question 4.) decides to add Chlorine for disinfection of its water. How would IDEM classify the water treatment system?

- A. WT1
- B. WT2
- C. WT5
- D. DSS

Question 6.

How does an operator become an operator-in-responsible-charge?

- A. The operator petitions the Commissioner of IDEM
- B. The operator is designated by the owner or governing body of a water treatment plant or water distribution system
- C. The operator is appointed by the IDEM field inspector
- D. None of the above

Question 7.

An Operator-in-Training (OIT) may serve as operator in responsible charge.

- A. True
- B. False

Question 8.

A grandparented operator must fulfill the same continuing education requirements as an operator who has received certification by examination.

- A. True
- B. False

Question 9.

Wellhead protection is mandatory for which type of public water system?

- A. Community
- B. Noncommunity
- C. Both of the above
- D. None of the above

Question 10.

IDEM will issue a Notice of Violation if a water system operator, or other official, contacts the agency too frequently.

- A. True
- B. False



# Indiana Water Operator Training Manual

## Lesson Two – DSS operators

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### Contents

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Page	10	Coliform and nitrate monitoring
Page	12	Lead and copper monitoring
Page	13	Chemical contaminant monitoring
Page	14	Distribution system chlorine
Page	16	Self-graded student examination

## **DSS systems and operators**

Both water systems and water system operators receive classifications from IDEM. As discussed in lesson one, a Class DSS (distribution system small) system includes systems that:

- (A) serve a population of less than three thousand three hundred one (3,301); and
- (B) have no components other than:
  - (i) pressure tanks; or
  - (ii) storage tanks

A Grade DSS operator is a certified operator qualified to operate a Class DSS water distribution system after having fulfilled the following requirements:

- (A) Possess a high school diploma or its equivalent
- (B) Meet the qualifications of the certification rule
- (C) Attain a minimum of one (1) year of acceptable work experience in the operation of a Class DSS water distribution system

If the repeat sample confirms the result of the first test and a maximum contaminant level (MCL) has been exceeded, the water system will need to notify its consumers. Please refer to the Public Notification section of lesson one of this manual for a detailed discussion of when and how to notify the public.

It is important to note that if the first sample indicates a problem with the potential to cause public health concerns, such as biological contamination or the presence of toxic chemicals, the public must be notified immediately. The test results of a repeat sample can take days to determine. That is too long to wait if someone might become ill in the interim.

What you sample for and how often you do it depends in great part upon the size of your water system and the nature of your source water. All systems sample for coliforms, but may be required to sample for many other contaminants.

The Indiana Department of Environmental Management (IDEM) provides water systems with a Standardized Monitoring Framework to let you know what your sampling frequency should be for other contaminants. It looks something like this example.

**STANDARDIZED MONITORING FRAMEWORK 2 (SMF 2)**  
Without Exceeding Detection Limits, Maximum Contaminant Levels, or Action Levels

System Name: \_\_\_\_\_ Entry Point: 01 PWSID# \_\_\_\_\_

REGULATED Contaminants	First Compliance Period			Second Compliance Period			Third Compliance Period		
	1993	1994	1995	1996	1997	1998	1999	2000	2001
VOCs	Annual				Annual	Inc. one sample	Annual	Annual *	Annual
SOCs ***	Annual					Annual **			Annual
IOCs		Annual			Annual			Annual	
Asbestos									
PCBs & Dioxin									
Nitrate	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
Nitrite, Cyanide & Glyphosate									

\*\*\* Includes Pesticides      \* Regulated and Unregulated VOCs are required in 2000.

UNREGULATED Contaminants	Third Compliance Period		
	1999	2000	2001
VOCs		Annual	

\*\* 2,4-D, Alachlor, Atrazine, and Simazine are required in the first, second, third, and fourth quarter of 1998. Please contact the Drinking Water Branch at 317/208-1282 if you have any detections or exceed a maximum contaminant level.

Other Monitoring Requirements	1993	1994	1995	1996	1997	1998	1999	2000	2001
Bacteriological	2 per month	2 per month	2 per month	2 per month	2 per month	2 per month	2 per month	2 per month	2 per month
Sodium	One Sample Every Three Years				Annual			Annual	
Lead & Copper	Contact Lila Park at 317/208-1287 with questions concerning your lead and copper monitoring requirements.								
Radionuclides						Annual			

\*\* Your system detected Hexachlorobenzene and total Xylenes in 1998 and Atrazine in 1998. Please contact our office for your increased monitoring requirements for these contaminants.

## Pressure tanks

In many small groundwater systems, the well or wells pump into a pressure tank. The tank performs several functions. It stores water when the demand is low. It gives up water to the system without starting up the well(s) as long as there is sufficient pressure in the tank. It keeps the well pump(s) from cycling too often, which reduces operation and maintenance expense.

There are several types of pressure tanks:

### Standard galvanized pressure tank

The simplest galvanized pressure tank works by pumping water into it from the well(s) until the air trapped in the tank compresses to a predetermined pressure, say 50-100 pounds per square inch (PSI).

When the predetermined pressure is reached, a switch turns off the power to the well pump(s). When water is needed, the accumulated air pressure in the tank pushes out the water stored in the tank.

At some point, the air pressure in the tank drops down to another predetermined level, say 25-40 PSI, at which time, the pump switch turns back on and the process starts all over again.

Over a period of weeks or months, the water being pumped in and out of the tank will absorb the air in a pressure tank. The tank becomes "water logged." A sure sign of a water-logged tank is the frequent cycling of its pump(s).

A slightly different type of galvanized tank has its own air compressor. By running the compressor every once in awhile, the air in the tank can be replenished and too-frequent pump-cycling can be eliminated.

#### Precharged pressure tank

Similar in function to a standard pressure tank is a precharged one. This type of tank has a rigid float that moves up or down with the flow of water into and out of the tank.

The float helps to decrease the amount of air absorbed by the water, but some air still escapes into the water. An air compressor is necessary to recharge the tank from time to time.

#### Sealed diaphragm tank

Probably the best type of pressure tank is the sealed diaphragm tank. This tank is designed with a bladder that expands and contracts as water is pumped into the tank and withdrawn from the tank. The problem of water adsorption is almost completely eliminated.

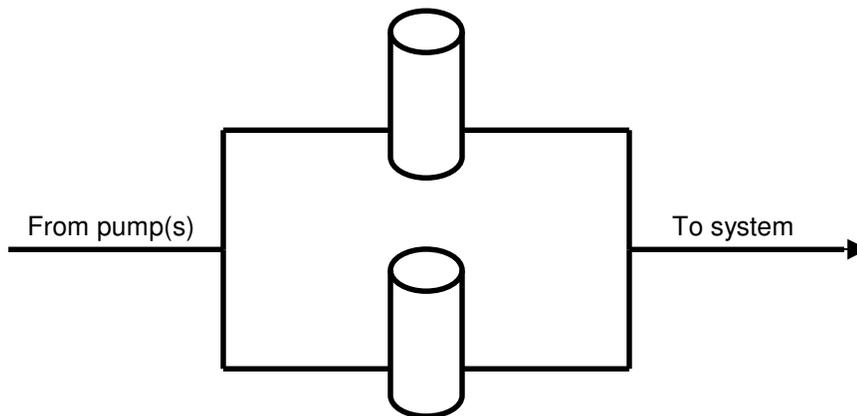
#### Pressure tank sizing

Pressure tanks need to be properly sized to avoid excessive cycling of the pump(s). A good rule of thumb is 10 gallons of storage for each gallon per minute of pump capacity. Here are some examples:

1. If well pumps 20 GPM, then tank = 200 gallons ( $10 \times 20 = 200$ )
2. If well pumps 30 GPM, then tank = 300 gallons ( $10 \times 30 = 300$ )

As a water system grows, it may be necessary to add additional pressure tank capacity. An existing tank can often be replaced with a larger tank, but this may not be desirable for one reason or another.

An alternative to replacement can be the addition of another tank. If you chose this option, be sure to plumb the new tank in parallel to the old tank so water flows equally between both tanks. This diagram shows a parallel layout:



## Storage tanks

Water distribution system storage tanks provide a function similar to pressure tanks, but use gravity or additional pumps to provide pressure instead of compressed air. In addition to reducing pump cycling and maintaining pressure, storage tanks can hold large amounts of water that allow systems to meet demands in excess of their pumping capacity for periods of time.

There are two main types of storage tanks.

### Ground level

A ground level tank is usually wider than it is high and is located on the surface or just below ground level. If the tank is located at about the same elevation as the wellhead(s), it will need its own pump to deliver water to the distribution system.

If the ground level tank is located at a much higher elevation than the wellhead(s), say on a hilltop above the town, the tank will deliver its water to the system by gravity.

### Elevated

Elevated tanks are usually taller than they are wide. If the tank is the same width (or diameter) at the bottom as it is at the top, it is called a standpipe. Visualize it as a pipe turned up on one of its ends.

A legged tank consists of a tank supported by several legs spaced at about the width of the tank. A single pipe running up between the legs to the center of the tank provides a path to fill and empty the tank. This pipe is called a riser.

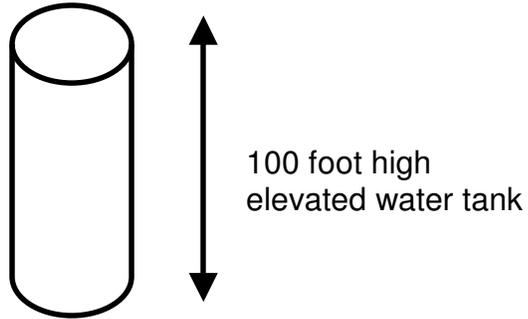
A pedestal tank has a single support running up from the ground to hold the tank. The tank's riser is located within the column. Pedestal tanks sometimes look a little like a huge golf ball on a tee.

As previously mentioned, elevated tanks get their pressure from gravity after the tank has been filled.

The following example will help you to figure out how much pressure a tank can provide at a given height:

1 foot of head (height) =  
.4333 PSI

2.31 feet of head = 1 PSI

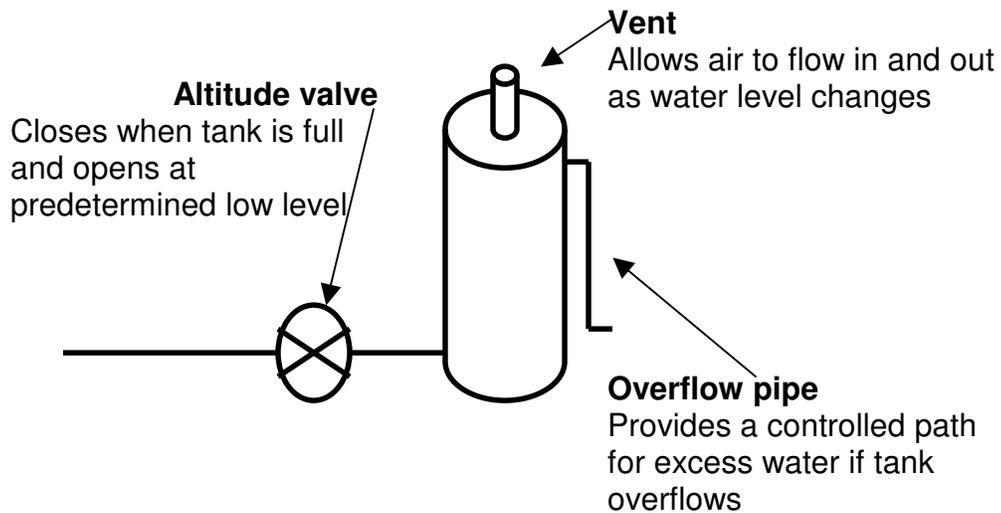


$$100 \times .4333 = 43.33 \text{ PSI}$$

If the tank pressure drops to 20 PSI, then there are only 8.66 feet of water in the tank.

$$20 \div 2.31 = 8.658$$

The following drawing illustrates the typical components of a water storage tank:



## Cross connection control

A cross connection is any actual or potential connection between a public water supply and a source of contamination or pollution. Some examples of where cross connections may occur include:

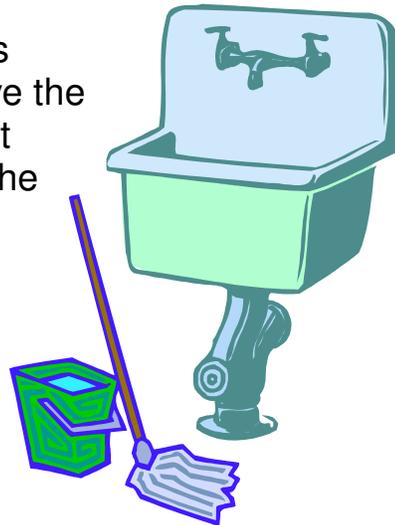
- Hospitals
- Cooling water tanks
- Mortuaries
- Lawn irrigation systems
- Fire suppression systems
- Mop sinks

It is important to note that while many cross connections do not result in contamination, a water system operator has no way of knowing when and if a cross connection will produce a problem.

Let us look at a mop sink an example of a cross connection.

In the drawing to the right, there is no cross connection because the faucet is well above the highest level of water the sink can hold. But imagine that there is a hose connected to the faucet. That hose runs into the sink or into the mop bucket.

In the above scenario, a cross connection would exist. Even if the faucet is turned off, a cross connection would still be there because the potential for contamination of the water system is present.



Imagine once again that the hose is in the bucket and a maintenance person is mixing up pesticides for use outside. The faucet is on and the hose is filling the bucket, mixing with the pesticides. There is a fire alarm and everyone runs outside.

The fire department arrives on the scene and starts to fill its tanker truck from a nearby hydrant. Because the pressure in the area is low, the fire department turns on a pump to withdraw the water more quickly.

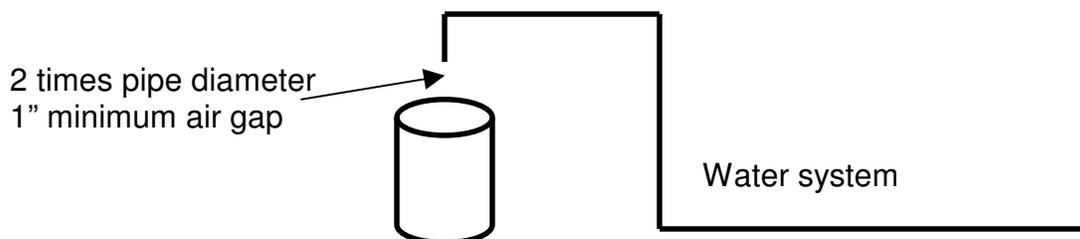
Good news. It is a false alarm. The fire department puts away its equipment and returns to the firehouse and everybody goes back to what they were doing.

The maintenance person returns to the sink and is surprised to find that instead of running over, the bucket is just starting to fill with water. The pesticides seem to have disappeared.

As a careful reader of this lesson, you have probably figured out where the pesticides went. They were sucked up into the water system when the fire department was filling its tanker truck. The cross connection allowed a backflow of contaminants into the water system.

Hopefully, in this case, no one became ill. But what if the sink were located in a hospital, nursing home or daycare center where the special population might be especially sensitive to contaminants?

The above thought exercise illustrates how dangerous cross connections can be. Many cross connections, however, can be easily avoided. An air gap is the best way to prevent cross connections. The gap should be at least two times the diameter of the water pipe near the potential cross connection, and always a minimum of one inch. The following drawing shows an example of this:



For additional information concerning cross connections and backflow control, please refer to lesson four of this manual.

## Coliform and nitrate monitoring

### Coliform

As we learned earlier in this lesson, coliforms are bacteria that are naturally present in the environment. Fecal coliforms and E. coli come from human and animal fecal waste. Total coliform are used as in indicator that other potential harmful bacteria may be present.

The following shows the frequency of coliform monitoring required for different sizes of water systems:

Population Served	Minimum Number of Samples Monthly
25 to 1,000	1
1,001 to 2,500	2
2,501 to 3,300	3
3,301 to 4,100	4
4,101 to 4,900	5
4,901 to 5,800	6

If a routine sample is unsatisfactory (positive), repeat samples must be taken within 24 hours of notification to the water system by the testing laboratory.

Normal samples per month	Number of repeat samples
1	at least 4
2 or more	at least 3

- 1 sample from location that produced positive
- 1 sample from within 5 connections upstream
- 1 sample from within 5 connections downstream
- 4th sample (if required) from anywhere else from system

If any repeat sample is positive, you must issue a public notification for an MCL violation: Tier 1 (immediate).

All public water systems are required to collect 5 distribution samples during the month after any unsatisfactory total coliform sample.

Here is an example of how that might be accomplished for a system that normally collects one coliform sample per month:

1 sample in May	OK
1 sample in June	Positive
4 more samples in June	All OK
5 samples in July	All OK
1 sample in August	OK (back to normal monitoring)

### Nitrate

Monitoring for nitrate by community public water supplies is based upon water source (ground or surface) and the levels of nitrate that have been previously detected in the system's water. Samples are obtained from the first place water can be drawn after any treatment, or the tap closest to the well if there is not any treatment.

The MCL for nitrate is 10 mg/l. If the nitrate level is in the range of 10– 20 mg/l, children 6 months and younger may not drink the water, and the public must be informed of this. If the nitrate level is greater than 20 mg/l, continuous public posting with health warnings must be made. In such a case, the system must remediate the contamination.

Appendix F located in the back of this manual contains a fact sheet on nitrate monitoring prepared by IDEM that the reader of this lesson may find useful.

## **Lead and copper monitoring**

All community and nontransient noncommunity water systems must monitor for lead and copper.

### Lead

Drinking water may corrode lead-containing plumbing materials such as faucets and solder. Short-term health effects from lead exposure include: interference with red blood cell chemistry, delays in normal physical and mental development in babies and young children, deficits in attention span, hearing and learning abilities of children and slight increases in the blood pressure of some adults. Long-term exposure can cause stroke, kidney disease and cancer.

### Copper

Drinking water may also corrode copper-containing plumbing materials such as pipes and valves. Copper is a nutrient that is metabolized by the body. Copper can cause the following health effects: stomach and intestinal distress, liver and kidney damage, and anemia. Persons with Wilson's Disease may be more sensitive than others to the effects of copper contamination.

### Action levels

An action level is a level, when the water is sampled, that ninety percent (90%) of samples must be below. The action level for lead (Pb) is 0.015 mg/L. The action level for copper (Cu) is 1.3 mg/L.

### Sampling

Lead and copper samples are collected at kitchen or bath cold water taps in homes and collected at drinking water taps in businesses. The water must have been in contact with plumbing for at least 6 hours. This is usually done in the morning and is known as a "first draw."

Initially, samples are collected for two consecutive six-month monitoring periods (January to June and July to December). Sampling is reduced to once per year for three years, and then once every three years.

This chart shows monitoring requirements by system size.

Number of Samples Required for Lead and Copper Sampling

System Size	Initial Monitoring	Reduced Monitoring
> 100,000	100	50
10,001 to 100,000	60	30
3,301 to 10,000	40	20
501 to 3,300	20	10
101 to 500	10	5
< 101	5	5

If an action level is exceeded, the water system should contact the Drinking Water Branch of IDEM immediately. Water quality testing will be required and treatment to reduce the corrosivity of the water may be undertaken. The water system will have to begin a public education program if the lead action level is exceeded.

### **Chemical contaminant monitoring**

All community and nontransient noncommunity water systems must monitor for chemical contaminants. These contaminants include:

- Inorganic chemicals (IOCs) that are naturally occurring contaminants
- Volatile organic compounds (VOCs) that include industrial solvents
- Synthetic organic compounds (SOCs) that are pesticides and herbicides

Exact monitoring requirements for chemical contaminants vary among water systems. Water systems should contact the Drinking Water Branch of IDEM for that system's specific requirements.

### Waivers

The Drinking Water Branch may grant a public water system a chemical monitoring waiver if the system meets established criteria for source type, nondetection, vulnerability, population and use of contaminants in the area.

These waivers may cover:

- Use waiver for VOCs and SOCs
- Use waiver for asbestos
- Statewide waiver for PCBs and dioxin
- Susceptibility waiver for glyphosate and cyanide

### **Distribution system chlorine**

If you chlorinate your system, you need to test the distribution system for chlorine. Always maintain a free chlorine residual at all points in the water system of at least .25 mg/l and no less than 1 mg/l total chlorine throughout the system. If .25 mg/l free chlorine cannot be obtained without going a lot over 1 mg/l total chlorine, say > 2 mg/l, look into possible problems such as iron bacteria, ammonia or other organics.

Please see lesson six for more information about chlorination.

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

To test your comprehension of the material included in lesson two, 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-2 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.

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# Indiana Water Operator Training

## Self-graded examination

### Lesson 2

Check one best answer per question

Question 1.

What is the minimum number of coliform samples all water systems must collect each month?

- A. 1
- B. 2
- C. 3
- D. 4

Question 2.

A foot of head (water height) produces how many pounds per square inch of pressure?

- A. .4333
- B. 2.574
- C. 3.141
- D. 5.333

Question 3.

Pressure tanks should be sized to avoid excessive pump cycling.

- A. True
- B. False

Question 4.

What is a cross connection?

- A. The process of connecting a hose to the large port of a fire hydrant
- B. Use of an electrically-powered tool in a moist environment
- C. Failure to turn off the power to a well when repacking a gland
- D. An actual or potential connection between a public water supply and a source of contamination or pollution

Question 5.

Under the Lead and Copper Rule, what percentage of tested water services must be below 0.015 Mg/l Lead (Pb)?

- A. 60
- B. 70
- C. 80
- D. 90

Question 6.

What does "first draw" mean when collecting lead and copper samples?

- A. Taking a sample after the water has been in contact with the plumbing for at least 6 hours
- B. Drawing a water sample from the faucet nearest the water meter
- C. Carrying the sample bottle in a leather holster affixed to the technician's belt
- D. None of the above

Question 7.

In the event you are notified that a coliform sample was positive, how many hours do you have to obtain a repeat sample?

- A. 8
- B. 12
- C. 24
- D. 48

Question 8.

What is the minimum air gap required to prevent a cross connection?

- A. 1 inch
- B. 4 inches
- C. 8 inches
- D. 1 foot

Question 9.

Synthetic organic compounds (SOCs) are found in:

- A. Industrial solvents
- B. Pesticides and herbicides
- C. Naturally occurring contaminants
- D. All of the above

Question 10.

May IDEM grant a chemical contaminant monitoring waiver for asbestos?

- A. Yes
- B. No



# Indiana Water Operator Training Manual

## Lesson Three – DSM operators

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### Contents

Page	2	DSM systems and operators
Page	2	Storage tank booster pumps
Page	4	Pump maintenance
Page	6	Records
Page	7	Meter selection
Page	9	Pressure vessels
Page	11	Distribution system flushing
Page	14	Self-graded student examination

## **DSM systems and operators**

Both water systems and water system operators receive classifications from IDEM. As discussed in lesson one, a class DSM (distribution system medium) system includes systems that meet one of the following:

- (A) Serve a population greater than or equal to three thousand three hundred one (3,301) but less than or equal to ten thousand (10,000) people and have no mechanical means of movement of water other than one (1) of the following:
  - (i) Pressure tanks
  - (ii) Storage tanks
- (B) Consist of the following:
  - (i) Pump
  - (ii) Storage tanks
  - (iii) Booster pumps to storage tanks

A DSM operator is a certified operator qualified to operate a Class DSS and DSM water distribution system after having fulfilled the following requirements:

- (A) Possess a high school diploma or its equivalent
- (B) Meet the qualifications of the certification rule
- (C) Attain one (1) of the following acceptable work experience requirements:
  - (i) One (1) year in the operation of a Class DSM water distribution system
  - (ii) Two (2) years in the operation of a Class DSS water distribution system

## **Storage tank booster pumps**

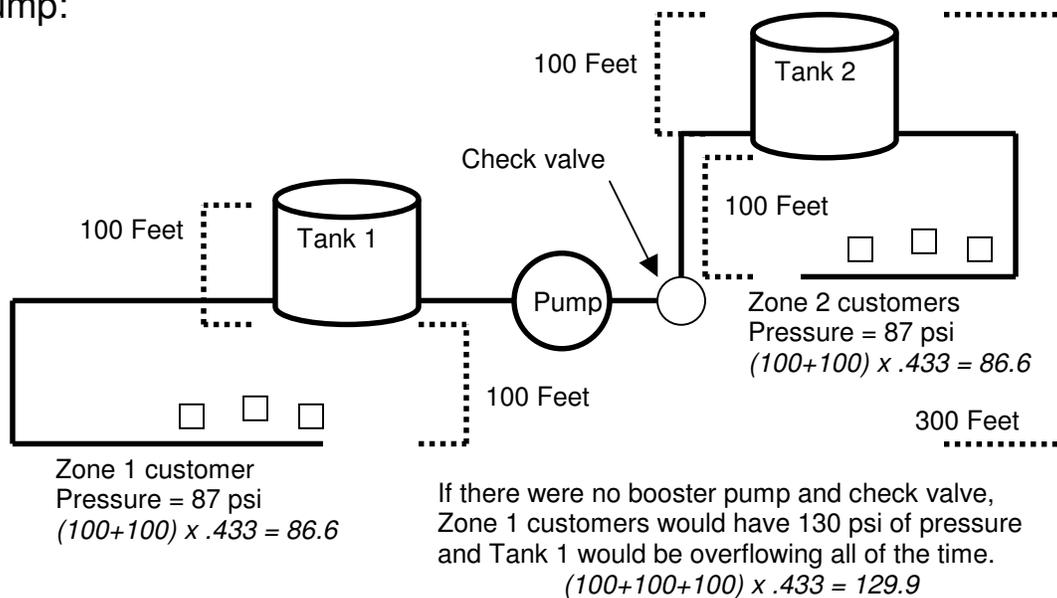
In some small water systems, elevated storage tanks may not be practical. Such tanks are expensive to construct and maintain. While a shallow well pump or submersible pump and pressure tank may provide adequate pressures if the distribution system is small and within generally level terrain, long pipe runs (especially uphill) may result in unacceptably low pressures.

An inline booster pump can be added to a water system to increase pressures. Small inline pumps are sometimes referred to as demand pumps. These pumps have a pressure control switch that senses a drop in pressure and turns on the pump. When the pressure in the system gets high enough again, the pump shuts off.

Inline booster pumps function very much as do water system pumps for large recreational vehicles.

Larger water systems may have very long runs of pipe and hilly terrain. These systems will often have distribution system storage tanks. To increase system pressures and fill the storage tanks, large pumps known as booster pumps are necessary. The structure in which these pumps are installed is called a booster station.

This drawing shows a typical water system employing a booster pump:



## **Pump maintenance**

Proper pump maintenance extends the useful life of the pump. Longer life translates into money saved and more dependable and reliable service.

Different types of pumps require different levels of maintenance. Let us examine some of the more common kinds of pumps.

### Centrifugal pump

Small centrifugal pumps are often used to pump water from shallow wells. These pumps suck the water up through a pipe, much as one might draw up a soda with a straw. Since they depend upon atmospheric pressure to push the water up the intake pipe, they will only withdraw water down to about 25 feet.

Components of a centrifugal pump include:

- Suction pipe
- Impeller
- Discharge pipe
- Motor
- Shaft

Very little maintenance of these kinds of pumps is required. The most important aspects of long-term operation of these units are the proper installation of the pump (following the manufacturer's instruction) and keeping the impeller free of debris, sand, etc. Keeping the pump primed is also very important. Dry impellers will self-destruct in a very short time if run without water.

### Jet pump

Jet pumps are centrifugal pumps that use a venturi to increase the effectiveness of the pump. A venturi is a restriction at the nozzle on the suction pipe that creates a vacuum as water from the impeller passes it. The vacuum draws the water up the well through the suction tube and into the main flow going through the impeller.

Maintenance requirements for jet pumps are about the same as for centrifugal pumps.

### Submersible pumps

These pumps are designed to be placed within the well casing. Submersibles are constructed as an all-in-one unit containing a motor, turbine pump and water screen. Their motors usually operate at about 3,600 revolutions per minute (RPM).

Small pumps of this type, say one to four or six inches, are basically “throw-a-ways.” They are sealed at the factory and are not designed to be repaired. Qualified personnel can repair larger units. Repair of a submersible pump is not a do-it-yourself project.

### Deep well turbines

Deep well turbines consist of both underground and aboveground components. The pump’s bowl and turbine are submerged and the motor is mounted aboveground with a connecting drive shaft inside the column (discharge) pipe. Pump motors usually run at about 1,800 RPM.

Proper maintenance of these pumps is important to help ensure long life. Automatic oilers must be checked regularly and kept full of the proper lubricant. Any glands should be properly packed with the recommended material and checked regularly. Shaft alignment is critical and must be properly maintained. Adequate electrical power must be maintained. Higher horsepower motors may be multi-phased and require 220, 440 or 880 voltages. Proper safety procedures must be followed at all times.

Most pump maintenance is preventive in nature. Here are some suggestions:

- Lubricate at recommended intervals
- Use the recommended lubricants
- Use the proper packing materials
- Do not over-tighten packing glands

- Keep everything aligned
- Exercise isolation valves
- Keep spare parts on hand
- Schedule maintenance instead of emergency response
- Keep good records

Keep four main things in mind about pump maintenance.

- Look for
  - Proper alignment
  - Leaks
  
- Listen for
  - Squealing
  - Grinding
  
- Touch for
  - Temperature
  - Vibration
  
- Record for comparison
  - Pressure
  - Flow
  - Electrical current

*Remember, change in most of these conditions usually is not good, but better to get bad news early than too late.*

## **Records**

Maintaining proper records of the operation of a water system can be a hassle but is worth the trouble. Records can paint a history of a water system. A water system operator can show compliance with regulations with proper records. A written history helps to deal with problems that are new to the current operator, but have been dealt with by others in the past.

Examples of records that are often maintained by water systems include:

- Laboratory tests
- Financial matters
- Valves and hydrants
- Maintenance logs
- System maps
- As-builts\*
- Manuals
- Customer complaints

*\*Maps or drawings depicting the actual installation of pipes and equipment. Also called record drawings. As-builts often differ from original plans.*

Some records must be retained for certain periods of time by IDEM regulations:

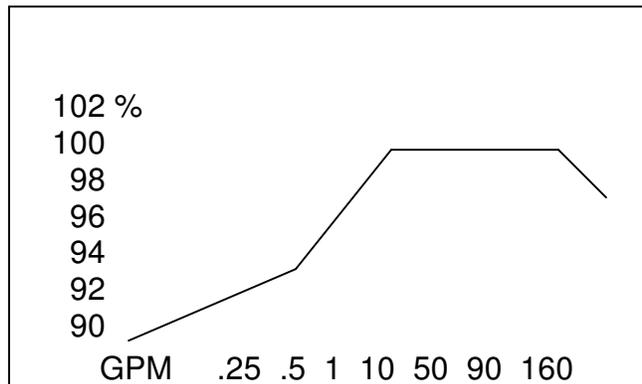
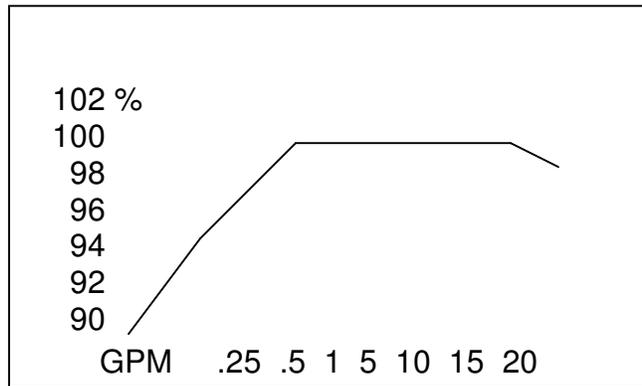
- |                             |          |
|-----------------------------|----------|
| ➤ Bacteriological           | 5 years  |
| ➤ Radiological and chemical | 10 years |
| ➤ Lead & copper             | 12 years |
| ➤ Violation remediation     | 3 years  |
| ➤ Sanitary surveys          | 10 years |
| ➤ Variances                 | 5 years  |

### **Meter selection**

Water meters are often said to be like cash registers for your business. If you sell water to your customers, you need to be able to show that the charges are related to the amount of the water consumed by the user.

Meters are a necessity for plant operation. The proper mixing of chemicals depends upon knowing how much water you are dealing with. Meters may be required to determine backwash rates.

Be sure to match meter characteristics to normal demands. The wrong type of meter for a particular application may result in inaccurate readings. That makes for unhappy customers and bad operations.



These charts show the accuracy curves for a 5/8" x 3/4" and 2" meter. The meter is accurate down to about .25 GPM, but cannot pass more than about 20 GPM.

The 2" meter can meter up to about 160 GPM, but its accuracy falls way off below 1 GPM. It probably will not even register very small flows like dripping leaks.

The two basic types of water meters are positive displacement (piston or disk) and turbine. Positive displacement meters are best applied at lower flows, say .25 to 150 GPM. These meters are sized from about 1/2" to 2". At flows above about 150 GPM, turbine meters are usually the best choice.

Turbine meters are sized beginning at 3" and go up to about 20". Most modern meters use magnetically-coupled registers to allow register changes without removing the meter.

As with most rules, there are exceptions. There are several small turbine meters that can work in residential settings. Make sure the meter you choose is American Water Works Association (AWWA) compliant and appropriate for the flow range application.

## **Pressure vessels**

Certain types of pressurized water tanks, water softeners and other specialized water treatment equipment may be classified as *pressure vessels* by the Indiana Department of Homeland Security (DHS).

Generally speaking, pressure vessels are regulated if they are located in an area intended for public assembly for civic, educational, worship, correctional, entertainment and other similar purposes.

A water treatment plant usually is not considered an area of public assembly, however, a water treatment facility located in a school, church, prison or other qualifying facility, containing a pressure vessel, may be subject to regulation by DHS.

There are exemptions to the pressure vessel regulations that may be found on the next page of this manual.

If you have questions concerning pressure vessels, you should contact the DHS Boiler and Pressure Vessel Safety Division at 317-232-1921. Its Website may be visited at <http://www.in.gov/dhs/fire/branches/boilers/index.html>.

**Vessels Exempt from ASME Standard construction & Boiler and Pressure Vessel Safety  
Div. Regulation.**

- (a) "Regulated boiler or pressure vessel" refers to any part of a boiler or pressure vessel not described in subsection (b).
- (b) The term does not include any of the following:
- (1) Water heaters commonly known as domestic water heaters having a size and heat input that does not exceed that specified by the rules board.
  - (2) Pressure vessels other than nuclear vessels operated entirely full of water or other liquid that the rules board specifically found to be not materially more hazardous than water, if the temperature of the vessel's contents does not exceed one hundred eighty degrees Fahrenheit (180 F).
  - (3) Boilers and pressure vessels under federal regulation.
  - (4) Pressure vessels meeting the requirements of the Interstate Commerce Commission for shipment of liquids or gases under pressure.
  - (5) Air tanks located on vehicles operating under the rules of other state authorities and that are also used for carrying passengers or freight.
  - (6) Air tanks installed on the right-of-way of railroads and used directly in the operation of trains.
  - (7) Pressure vessels that were installed before July 1, 1971, and that have a volume of:
    - (A) fifteen (15) cubic feet or less if located in a place other than a place of public assembly; and
    - (B) five (5) cubic feet or less if located in a place of public assembly.
  - (8) Pressure vessels, other than nuclear vessels that were installed after June 30, 1971, and that have a volume of:
    - (A) fifteen (15) cubic feet or less, if adequately protected by pressure relieving devices set to function at three hundred (300) pounds per square inch or less and located in a place other than a place of public assembly;
    - (B) five (5) cubic feet or less if adequately protected by pressure relieving devices set to function at two hundred fifty (250) pounds per square inch or less and located in a place of public assembly; or
    - (C) one and one-half (1 1/2) cubic feet or less regardless of pressure or location, unless otherwise covered by this article.
  - (9) Pressure vessels, other than nuclear vessels protected by adequate pressure relieving devices, set to function at not over fifteen (15) pounds per square inch gauge.
  - (10) Pressure vessels containing liquified petroleum gases and regulated by the commission.
  - (11) Surgical sterilizers, coffee urns, and steam jacketed food cookers that do not exceed size limits specified by the rules board.
  - (12) Commercial toy boilers and miniature model boilers constructed as a hobby that do not exceed a size specified by the board.
  - (13) Pressure vessels containing anhydrous ammonia, used in transportation, distribution, or use storage of the product as a liquid fertilizer, and for which a general scheme of construction, installation, and safety requirements has been adopted by statute or rule of another state agency. This exemption does not apply to vessels in refineries or in manufacturing or processing plants.
  - (14) Nuclear vessels for the collection and disposal of nuclear waste from a nuclear energy system that are not subject to pressures greater than would prevail if they were vented to the atmosphere.
  - (15) Standard and miniature traction engine boilers and other boilers used solely for exhibition purposes.
  - (16) A locomotive boiler used only on a railway that is used as a tourist attraction.

## Distribution system flushing

Water main flushing is performed to maintain water quality in the distribution system and provides the opportunity to test valves and hydrants.

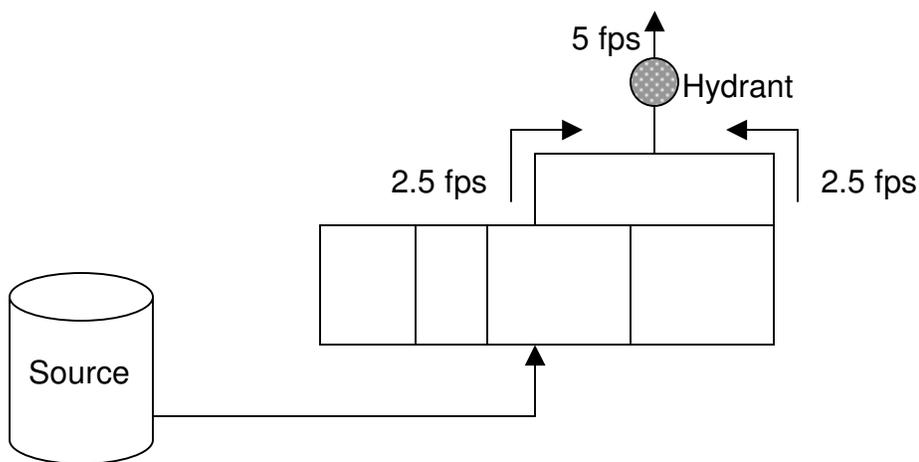
Safety is always an issue with system flushing. Running water attracts children and adult spectators. Traffic control is very important. If you will be working in the public right-of-way, be sure to coordinate your activities with local authorities.

Think about where the water will go. Flushed water loves basements, garages, driveways and flowerbeds.

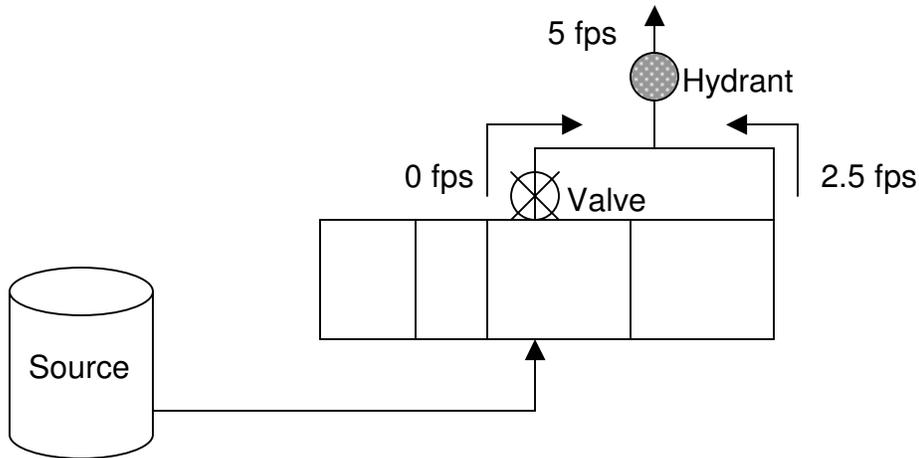
There are two kinds of flushing: Multi-directional (multiple directions at the same time) and unidirectional (only one direction at a time). Both types should start from the source of supply, and work out from there. The idea is to always flush with clean water.

Flushing should obtain a minimum velocity 2.5 feet per second within the pipe being flushed. Ideally, the velocity should reach 5 feet per second.

Here is an example of multi-directional flushing:



This drawing illustrates unidirectional flushing:



To calculate the velocity of water in a pipe, we need to understand how to figure the volume (amount) of water in the pipe.

### Calculating volumes

$$V = A \times L$$

V = Volume in cu. ft.

A = (area in square ft.) =  $\pi \times R$  (squared-number times itself)

$\pi = 3.14$  ( $\pi$  is a Greek letter Pi pronounced pie)

R = radius of main (in feet); radius is  $\frac{1}{2}$  the diameter

$\pi$  is the ratio of a circle's circumference divided by its diameter:

$22 \div 7 = 3.142857$  (rounded to 3.14)

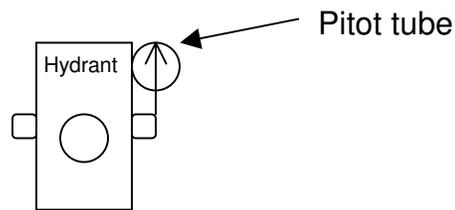
L = Length of main (in feet)

$V = A \times L$ $V$ (cu. ft.) = $[3.14 \times (.5\text{ft} \times .5\text{ft.})] \times 500$ ft. $V$ (cu. ft.) = $[3.14 \times (.25 \text{ sq. ft.})] \times 500$ ft. $V$ (cu. ft.) = $.785 \text{ sq. ft.} \times 500$ ft. $V$ (cu. ft.) = 392.5 cu. ft.	1 cubic foot of water = 7.48 gallons of water $V$ (gallons) = 392.5 cu. ft. $\times$ 7.48 gallons/cu. ft. $V$ (gallons) = 2,935.9 gallons
--	---

Example: 500 ft. of 12" water main has how many gallons of water in it?

We now know that 500 feet of 12" water main has 2,936 gallons of water in it. 500 feet divided by 2.5 fps (the minimum velocity we need to flush properly) = 200 seconds or 3.33 minutes. 2,936 gallons divided by 3.33 minutes = 882 GPM.

882 GPM is the rate-of-flow we need. To measure the flow from the hydrant a Pitot tube (gauge) is used. These are obtained from most water works suppliers, or might be borrowed from the local fire department. The tube is placed into the flow of the hydrant and the gauge will display the flow based on the water pressure and the size of the port on the hydrant.



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

To test your comprehension of the material included in lesson three, 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-3 of this manual.

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# Indiana Water Operator Training

## Self-graded examination

### Lesson 3

Check one best answer per question

Question 1.

Why might a distribution system have multiple pressure districts (zones)?

- A. To store extra water in case of emergency
- B. To avoid excessively high pressure in low lying areas
- C. To reduce pump maintenance requirements
- D. To separate cold and hot water tanks

Question 2.

In a jet pump, the venturi should be at least 18 inches from the suction tube.

- A. True
- B. False

Question 3.

In a deep well turbine, the motor is located below the impeller.

- A. True
- B. False

Question 4.

Which item is not a good pump maintenance practice?

- A. Tighten packing glands until they stop leaking
- B. Use the proper packing materials
- C. Keep spare parts on hand
- D. Keep the manuals and refer to them

Question 5.

Records of sanitary surveys should be retained for at least:

- A. 2 years
- B. 4 years
- C. 8 years
- D. 10 years

Question 6.

A 2-inch water meter is more accurate at very low flows than a 5/8"x3/4" meter.

- A. True
- B. False

Question 7.

Nutating and piston disk water meters are examples of displacement meters.

- A. True
- B. False

Question 8.

Turbine water meters are generally a better choice for very high flows than displacement meters.

- A. True
- B. False

Question 9.

What is the minimum desired water flow velocity when flushing a distribution system?

- A. 1 foot per second
- B. 2.5 feet per second
- C. 10 feet per second
- D. 25 feet per second

Question 10.

A water system's Sample Site Plan should be:

- A. Kept on file at the water system and available for review by IDEM field personnel
- B. Sent to the Drinking Water Branch for review and filing
- C. Updated regularly to reflect actual practices
- D. All of the above



# Indiana Water Operator Training Manual

## Lesson Four – DSL operators

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### Contents

Page	2	DSL systems and operators
Page	4	Distribution system booster pumps
Page	5	Backflow prevention
Page	6	Storage tank maintenance
Page	12	System security
Page	15	Self-graded student examination

## **DSL systems and operators**

Both water systems and water system operators receive classifications from IDEM. As discussed in lesson one, a Class DSL (distribution system large) includes systems that meet one of the following:

- (A) Serve a population greater than or equal to ten thousand one (10,001) people, or more
- (B) Consist of the following:
  - (i) Storage tanks
  - (ii) Booster pumps to the distribution system
  - (iii) Mechanical devices for movement of water beyond storage

A grade DSL operator is a certified operator qualified to operate a Class DSS, DSM, and DSL water distribution system 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 one (1) of the following acceptable work experience requirements:
  - (i) One (1) year in the operation of a Class DSL water distribution system
  - (ii) Three (3) years in the operation of a Class DSM water distribution system
  - (iii) Five (5) years in the operation of a Class DSS water distribution system
  - (iv) An acceptable number of years of experience approved by the Commissioner if gained in operation of a combination of the various classifications of water distribution systems

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

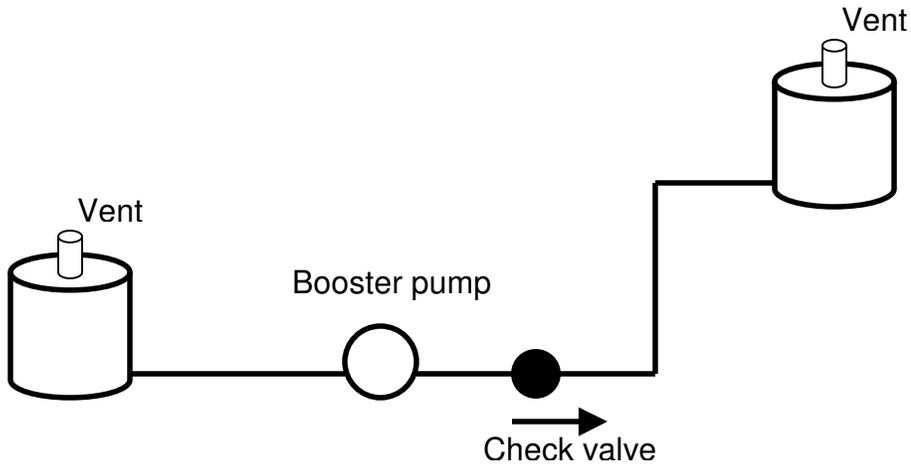
(ii) transfer an OIT certification to a water treatment plant or distribution system with a public water system identification number (PWSID) different than the PWSID for which the certification was issued;

(iii) hold two (2) treatment plant or distribution system OIT certifications concurrently; or

(iv) renew the OIT certification

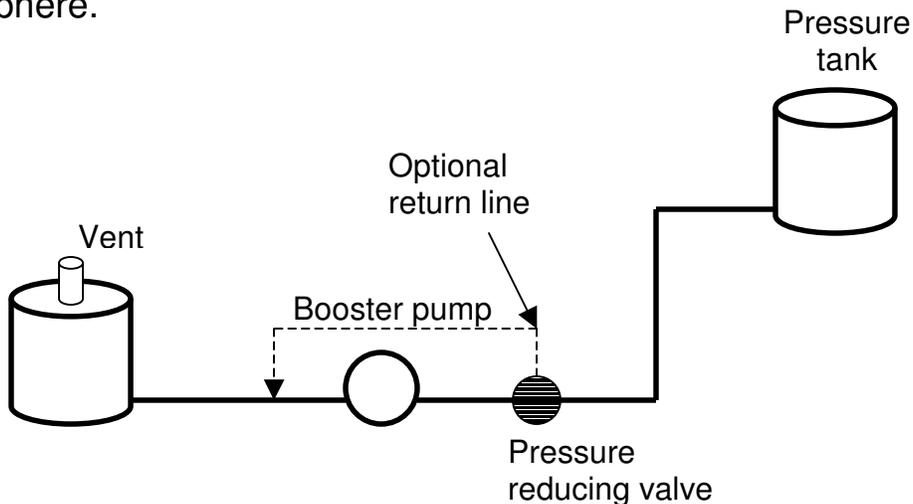
## Distribution system booster pumps

In lesson three, a discussion was conducted concerning pressure zones and booster pumps. We learned that distribution systems may have multiple pressure zones (districts). This might happen when a system has a group of customers located at a significantly higher elevation than its other customers. A booster pump will transfer water from the lower zone to the higher zone.



The above drawing illustrates an “open” pressure zone system. Water is pumped to higher-pressure zone that is opened to the atmosphere.

The drawing below shows a “closed” pressure zone system, where water is pumped to a higher-pressure zone that is closed to the atmosphere.



The return line helps prevent over-pressurization and pump damage.

## Backflow prevention

Backflow is an unwanted reversal of water flow. There are two types of backflow. “Backpressure” backflow occurs when *downstream* pressure increases or *upstream* pressure drops. “Backsiphonage” backflow is when there is negative (vacuum or partial-vacuum) pressure.

In lesson three, an example of backsiphonage was presented. In that case, a fire department tanker truck pumped water from a hydrant and created a negative (partial vacuum) pressure, sucking pesticides from a mop bucket into the distribution system.

A backpressure scenario might go something like this:

A worker at a factory decides to add water and a corrosion inhibitor, hexavalent chromium, to the cooling water tank. A pump that operates at 70 psi is used. The city water system near the factory operates at a pressure of about 50 psi. The water company does not have a backflow prevention program and there are no backflow prevention devices installed at the factory.

You can imagine the rest of the story. The worker somehow turns a wrong valve and chromium flows into the city’s water distribution system.

Here are some examples of backflow prevention devices:

- Air gap twice the pipe diameter with a 1” minimum is the best protection available
- Reduced pressure principle (RP) backpressure and backsiphonage
- Pressure vacuum breaker (PVB) backsiphonage
- Atmospheric vacuum breaker (AVB) backsiphonage
- Double check valve assembly (DC) for non-health endangering substances

No water system is too small to have a backflow prevention program. Do farmers fill chemical tanks from your water system? A hose hanging into a tank of chemicals or filling the tank from the bottom without a check valve can result in a cross connection that might allow backflow into the water system.

IDEM has prepared a fact sheet on cross connections that may be found in Appendix C of this manual.

### **Storage tank maintenance**

There are at least 30 different types of water storage tanks in use today. Some of the most popular are:

- Welded standpipe
- Concrete standpipe
- Concrete ground level
- Legged
- Pedestal

Please refer to lesson three for a discussion of these basic types of tanks.

Storage tanks represent a significant investment for most water systems. Maintaining a water tank helps ensure a long life, sometimes in excess of 100 years. Let us examine a few tank-maintenance considerations

#### Safety first

- Stay off your tank if you don't know what you're doing
  - A good superintendent can be harder to replace than an engineer or tank inspector
- Not all safety belts are safe for tank work

- A six-foot fall can break your back with only a waist belt and rope
- Always use the proper climbing equipment
  - Full harness
  - Rail-mounted belt

## Vandals

Keep them off your tank with fences, ladder gates and good locks. Sometimes vandals can be fooled. One water system operator, tired of people climbing the tank, simply placed a large “DANGER, HIGH VOLTAGE” sign near the tank. It worked.

## Exterior inspection

- Check foundations for cracking, spalling (flaking), exposed reinforcing metal or settling
- Keep vegetation away from foundations
- Trim limbs that may scratch surfaces
- Look for rust stains that may indicate leaks
- Inspect vent and overflow screens for holes or debris
- Check for signs of overflow
- Check for signs of unauthorized entry
- Look for loose bolts/nuts
- Check for paint flaking
- Look for rotation of columns or tower

## Interior inspection

Ideally, tanks should be inspected annually. In the real world, this probably is not practical, but an interior inspection every five years or so is doable for most water systems. Here is what to look for:

- Interior roof condition
- Corrosion
- Leaks
- Silt depth
- Cathodic protection system condition

Usually the best interior-inspection method is the dry method, which requires the draining of the tank. A dry inspection allows for the most thorough inspection, but there are disadvantages:

- The tank must be taken out of service
- The interior of the tank can (and should) be cleaned
- A lot of water is wasted
- The method has the greatest potential for tank worker injury
- It is the most expensive method
- Once drained, the tank must be disinfected before returning it to service

A good method of interior inspection is the wet method, using a diver. The method has both pros and cons:

- The tank must be taken out of service
- There is no opportunity to clean the tank
- There is no wasted water
- There is less potential for personal injury to tank workers
- It is not as thorough method of inspection as dry method
- It is less expensive than dry method
- There are some sanitary concerns (customers might not like the idea of someone swimming around in their drinking water)

A fairly new method of interior tank inspection is the remotely operated vehicle (ROV) method. Visualize a cabled-controlled, underwater, motorized device with a floodlight and TV camera. With this method:

- The tank remains in-service
- There is no opportunity to clean the tank
- There is no wasted water
- It has the least potential for personal injury to tank workers
- It is the least thorough inspection method
- It is the cheapest method
- There are few sanitary concerns

## Cathodic Protection

Cathodic protection systems are used in the water works industry to protect water storage tanks from corrosion caused by electrical current flow that naturally occurs between dissimilar materials, such as minerals in water and the steel plates of a water tank. Metal from the inside surface of a water tank can flow into the stored water because of the impurities in the stored water.

If a sacrificial piece of metal (an anode) is placed into the water and a reverse current is applied, metal flows from the sacrificial anode into the water instead of metal flowing from the inside wall of the tank.

Remember, cathodic protection is not a substitute for a properly-painted (coated) tank interior. Cathodic protection only helps with the metal that is in contact with the water; not the interior roof and upper sides that do not come into contact with the water.

Be sure to keep current/voltage at recommended settings (check monthly). At 1.2 volts and higher, hydrogen gas may start to form and interior coatings will start to fail due to the bubbling of the gas. Anodes should be inspected and/or replaced annually or as recommended by the manufacturer.

## Altitude Valves

Altitude valves are large valves inserted at the base of an elevated water tank, standpipe or reservoir. There are two types of altitude valves.

A one-way valve opens only at one predetermined low level of pressure to fill the storage structure. It closes when a second, higher-pressure level is reached. Water flows in one direction only (into the storage structure). After it closes, it stays closed until the low level setting is again reached. Water is removed through another valve, pipe, pump, etc.

A two-way altitude valve, more common in elevated tanks, allows water to flow in two directions. This valve is adjusted to close when a high-pressure setting is reached. It opens when the maximum pressure is reached. This keeps the tank from overflowing. When the pressure is lower than the high set point, the valve remains open and allows water to flow in and out of the tank.

Altitude valves require minimal maintenance. The most important thing to do is to be sure that the valve and its connecting pipes are free of debris when installed. This writer has found soda cans, rocks, paper cups and lumber inside of altitude valves, left over during construction.

Clogged snubbers cause many problems with altitude valves. Please see the next section for more information about these fittings.

### Snubbers

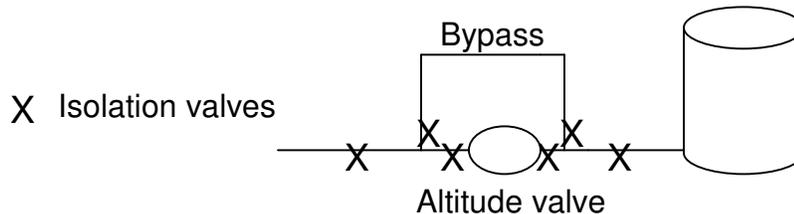
Snubbers are small fittings that restrict flows, preventing rapid pressure changes. Snubbers help prevent “water hammer” damage to gauges and help altitude valves to operate smoothly. Water hammer is a shock wave in a water system usually caused by the rapid closing of a valve.

This phenomenon can be heard in home plumbing when the washing machine water valve turns off quickly. This writer has seen a fire hydrant dislodged from its setting as a result of water hammer in a water distribution system.

There is no regularly required maintenance for these snubbers. When gauges or altitude valves exhibit erratic behavior, check the snubber first.

## Isolation valves

Water tank isolation valves are critical to your system. A tank cannot be taken off line (or put it back on line) if the isolation valves do not work. Just like people, valves need exercising.



## Vents

Non-pressured storage tanks have vents. These vents allow air to move into and out of the tank as the water level goes up and down. Vents should be screened to prevent debris and animals from entering the tank. Keep vents clear. A tank can buckle if a clogged vent allows a vacuum to be drawn within the tank, much as a soda straw collapses when you are trying to drink a thick milkshake.

## Overflow pipes

Elevated storage tanks have overflow pipes connected near the top of the tank and running on the outside to the bottom of the tank and away from the base. The purpose of the overflow pipe is to safely direct overflowing water away from the tank where it will not pond or wash away the tank's foundation.

Like the tank vent, the overflow pipe should be screened. Water must be free to flow away from the tank. The system must be designed to prevent the discharge end of the overflow pipe from becoming submerged underwater. Such a condition would result in a cross connection and could result in backflow into the tank.

## Antenna systems

Elevated water tanks can make great platforms for radio antennae. The local fire department or cellular telephone company may want to locate its radio system at your water tank site. Granting such a request can be helpful to your community and might produce some additional income for your water system.

Be careful. A poorly designed/installed radio system can make your tank unsafe to climb and maintain. Here are a few tips to consider before allowing a radio system on your tank:

- Always have a lease agreement
- Never accept the radio system's "standard agreement"
  - Consult with an attorney
- Always employ a qualified engineer to review plans and inspect construction
- Never allow cables to interfere with climbing and safety systems
- Ask yourself
  - Can you repaint the tank and not interfere with the operation of the radio system?
  - Who will remove the system when it is no longer needed?

## **System security**

The three "D"s of security are Deter, Detect and Delay. Intrusion should be deterred, and detected if it occurs. Intruders should be slowed down (delayed) as much as possible to allow more time for their apprehension.

Water system security steps include:

### 1. Vulnerability assessment

Identify vulnerabilities such as doors, windows, hatches and locations in remote areas.

## 2. Eliminate or mediate vulnerabilities

Install locks and use them. Install fences, alarms and security lights. Ask for police patrols. Consider asking neighbors to watch over your facilities for you (adopt-a-facility).

## 3. Emergency response

Know who to call in an emergency. Create a list of emergency telephone numbers.

- Fire
- Police
- IDEM
- Local health department
- Critical users
- Your boss
- Government officials
- Nearby water systems
- Laboratories
- Contractors
- Chemical suppliers
- Parts/equipment suppliers
- Insurance agent
- Local media (radio, TV and newspaper)

Plan ahead for your emergencies. Think about what might go wrong, and try to plan for it. Like a good scout, “be prepared.” Always remember, people come first, then property. Be safe and do not take unnecessary risks.

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

To test your comprehension of the material included in lesson four, 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-4 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 4

#### Check one best answer per question

Question 1.

An open distribution system booster pumps to a higher-pressure zone that is closed to the atmosphere.

- A. True
- B. False

Question 2.

A backsiphonage backflow is caused by:

- A. A drop in upstream pressure
- B. An increase in downstream pressure
- C. A negative (vacuum or partial vacuum) pressure
- D. Both A and B, above

Question 3.

What is the best backflow control device?

- A. Air gap
- B. Double check valve
- C. Reduced pressure principle
- D. Pressure vacuum breaker

Question 4.

A waist belt and rope are the best safety equipment when climbing a water tank.

- A. True
- B. False

Question 5.

Which is the best method for a thorough tank inspection?

- A. Microwave active radio
- B. Dry
- C. Remotely-operated vehicle
- D. Diver

Question 6.

What causes corrosion in a water tank?

- A. Radio frequency leakage from cell phone systems
- B. Chipped paint on the exterior of the tank
- C. Poor electrical grounding of the tank base
- D. Electrical current flow between dissimilar materials

Question 7.

What is a snubber?

- A. The valve that controls the height of the water in the tank
- B. A small fitting that prevents rapid pressure changes
- C. A grease fitting
- D. Part of a cathodic protection system

Question 8.

Ponding near a tank overflow pipe can cause a cross connection.

- A. True
- B. False

Question 9.

When leasing antenna space on your water tank, which of the following should you do?

- A. Never accept the radio system's "standard agreement"
- B. Always employ a qualified engineer to review plans and inspect construction
- C. Never allow cables to interfere with climbing and safety systems
- D. All of the above

Question 10.

The "3 Ds" of security are:

- A. Deter, detect, delay
- B. Detect, disable, detain
- C. Disinfect, discolor, drain
- D. None of the above



# Indiana Water Operator Training Manual

## Lesson Five – WT1 operators

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### Contents

Page	2	WT1 systems and operators
Page	2	Ground water
Page	3	Wellhead protection
Page	7	Isolation areas
Page	8	Basic ion exchange softening
Page	9	Inline filtration
Page	10	Interpretation of chemical and bacteriological sample reports
Page	14	Well disinfection
Page	16	Self-graded student examination

## **WT1 systems and operators**

Both water systems and water system operators receive classifications from IDEM. As discussed in lesson one, a class WT1 (Water Treatment 1) system includes systems that meet the following:

- (A) Serve a population less than or equal to five hundred (500) people
- (B) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (C) Have one (1) of the following:
  - (i) Ion exchange softening process for cation removal
  - (ii) Inline filtration device with no chemical treatment

A grade WT1 operator is a certified operator qualified to operate a class WT1 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 a minimum of one (1) year of acceptable work experience in the operation of a class WT1 water treatment plant

## **Ground water**

Ground water is the water found in an aquifer. So, what is an aquifer? It is a water-saturated underground formation that will yield usable amounts of water to a well or spring. The formation can be sand, gravel, limestone or sandstone.

There are two types of aquifers:

### Confined

A water-saturated formation between low-permeability layers that restrict movement of water vertically into or out of the saturated formation.

Water is confined under pressure similar to water in a pipeline.

In some areas, confined aquifers produce water without pumps (flowing artesian well).

### Unconfined

A water-saturated formation in which the upper surface fluctuates with addition or subtraction of water.

The upper surface of an unconfined aquifer is called the water table.

Water, contained in an unconfined aquifer, is free to move laterally in response to differences in the water table elevations.

## **Wellhead protection**

### Overview

Indiana's Wellhead Protection Program currently only applies to community water systems. In the future, it is possible that the program will be expanded to include noncommunity systems using a simplified process.



The purpose of Wellhead Protection is to safeguard ground water used by water systems from contamination. Wellhead Protection is implemented in two phases.

- | <u>Phase I</u>   | <u>Phase II</u>   |
|--|---|
| <ol style="list-style-type: none"> <li>1. Establish Local Planning Team</li> <li>2. Delineate Wellhead Protection Area</li> <li>3. Identify and inventory potential sources of contaminants</li> <li>4. Develop management plan for potential sources of contaminants</li> </ol> | <ol style="list-style-type: none"> <li>1. Management plan implementation</li> </ol> |

### Local Planning Team

The Local Planning Team (LPT) is charged with establishing a water system’s Wellhead Protection Program. The team members should be from the water system’s community. At least one member must be an “affected party.” This can be an emergency responder, representative of a local industry or a water system customer.

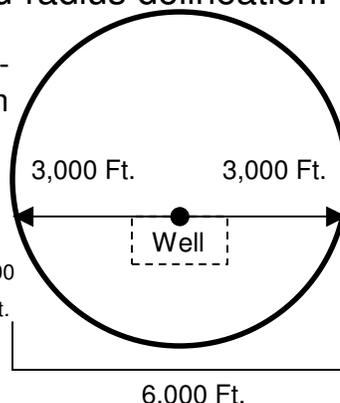
### Delineation

There are two main methods that water systems may use to delineate (define or draw) its Wellhead Protection Area (WHPA). If the water system pumps a maximum of less than 100,000 gallons per day (on average), it may use a fixed-radius delineation. The radius is 3,000 feet.

What is the area of a fixed-radius Wellhead Protection Area?

$$\text{Area of a circle} = \pi \times r^2$$

$$\begin{aligned} \pi &= 3.14 \\ 3.14 \times (3,000 \times 3,000) &= 3.14 \times 9,000,000 \\ 3.14 \times 9,000,000 &= 28,260,000 \text{ square ft.} \\ 1 \text{ Acre} &= 43,560 \text{ square ft.} \\ 28,260,000 \div 43,560 &= 648.76 \text{ Acres} \end{aligned}$$



Larger water systems (more than 100,000 gallons per day) use more complex methods to delineate a Wellhead Protection Area. These methods may include analytical, semi-analytical, numerical flow/solute transport and hydrogeologic/geomorphic modeling.

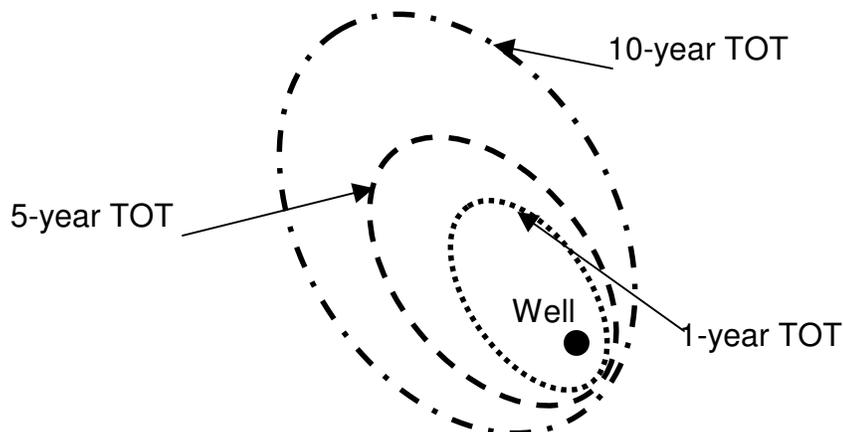
Hydrogeologists and engineers perform these types of methods of delineation. They use data available from the U.S. Geologic Survey, the Indiana Department of Natural Resources and other sources. Mathematical models are created and tested against known measurements.

Further technical discussions of these delineation methods are beyond the scope of this manual. The terms have been presented only for background purposes to familiarize the reader with the methods of delineation.

### Time-of-travel

Time-of-travel (TOT) is an important term that is often used in discussing wellhead protection. TOT examines a theoretical “particle” of water at a hypothetical location and predicts how long it will take for the particle to travel from a location to a wellhead.

When a WHPA is delineated by a method other than fixed-radius, the TOT is plotted. 1-, 5- and 10-year TOTs are determined and the 5- or 10-year TOT is designated as the WHPA. A 5-year TOT is the minimum required area allowed under Indiana’s Wellhead Protection Rule.



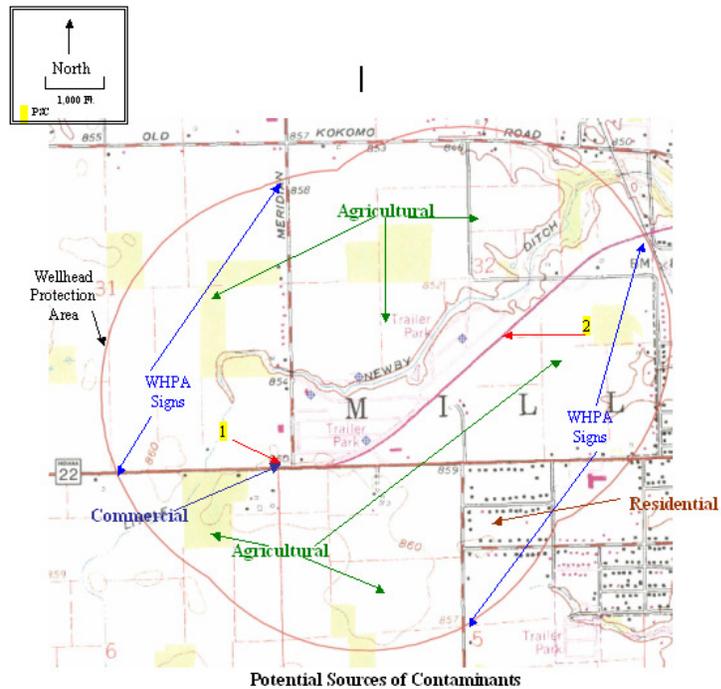
## Inventory

After the WHPA has been determined, the LPT needs to take an inventory of potential sources of contaminants. Here is an example of a contaminant inventory:

Map ID	Permit Number & Issuing Agency	Database Description	Facility Name	Description	Location	Potential Contaminants	Comments
1	UST ID 8695 Incident Number 199312525 Ind. Dept. of Environmental Management	Underground Storage Tanks Leaking Underground Storage Tanks	Dave's Stop N Shop	Convenience store & gas station	975 E 500 S, S. Marion, IN	Gasoline & additives	Active. Spill affecting soil and groundwater. 1-12,000, 1-8,000 & 1-6,000 gasoline tanks.
2	N/A	Windshield Survey	Indiana State Road 22	Public highway	Immediately south of park running east & west	Automotive fluids, road salts and possible of spills	Active

These inventories should be updated on an annual basis. A map showing the location of potential contaminants and land uses should also be prepared.

All potential contaminants sources must be informed of their location within a WHPA. They should be informed about the consequences of ground water contamination and be informed about the methods available to prevent contamination.



## Contingencies

Every wellhead protection plan should have a section to address these contingencies.

- Water outages
- Water contamination
- Critical water users
- Long-term loss of water

The plan also should cover:

- Responder training
- Emergency contact list

## **Isolation areas**

Also known as sanitary setbacks, isolation areas are those lands immediately surrounding a well. They are intended to provide a buffer against pollution of wells. Isolation areas have a 200-foot radius if the water system does not use automatic disinfection, such as chlorination. If automatic disinfection is used, the radius is reduced to 100 feet.

The public water supply should own or control the isolation area/sanitary setback by recorded deed, easement or long-term lease. No mixing of non-water treatment chemicals is permitted within the isolation area. Sanitary or storm water sewers are not permitted within 50 feet of any well.

No construction, other than that designed to contain a well, is allowed over a well. There may be no roads or parking areas within 50 feet of a well, except for well access.

## Basic ion exchange softening

Water is often referred to as  $H_2O$ . The reason for this is that water is the combination of two elements, hydrogen and oxygen. These elements come together to form a molecule made of two atoms of hydrogen and one atom of oxygen. Chlorine gas is often written as  $Cl_2$ . It is a molecule made of two atoms of chlorine.

An ion is a molecule or atom that has an electrical charge. When we speak of ion exchange in water softening, we do so because we are describing the movement of electrically charged- (positive or negative) atoms and molecules.

Just as the north pole of a magnet attracts the south pole of another magnetic, a positive ion will attract a negative ion (and vice versa).

Hard water has calcium (Ca) or magnesium (Mg) ions in it. Usually we measure hardness as calcium carbonate ( $CaCO_3$ ). It is a molecule made of one atom of calcium, one atom of carbon (C) and three atoms of oxygen. Hardness is usually measured in milligrams per liter (mg/l) or grains per gallon (GPG).

Using calcium carbonate as a measurement of hardness, water is classified as soft to very hard:

	<u>mg/l</u>	<u>GPG</u>
Soft water	0-17	0.0-1.0
Moderately hard water	60-120	3.5-7.0
Very hard water	180 & over	10.5 & over

(1 GPG = 17.1 mg/l)

Basic ion exchange softening works by exchanging the ions of sodium salts [sodium chloride ( $NaCl$ ) is common] for  $CaCO_3$ . The hardness is removed and replaced by salt.

Many very small water systems use readily available home-type water softeners. These units come with a tank of resin (the bed) through which hard water flows. A tank for salt often is included as part of the system. The tanks may be located separately or housed together as a single device.

Resin beds are filled with insoluble beads or spheres. The resin beads will allow either cations (positively charged ions) or anions (negatively charged ions) to attach to the surface of the spheres.

Now, here is an important part of this discussion. Only one cation or one anion can be attached to a resin bead at a time. In other words, only one sodium cation (positive), or only one calcium anion (negative) will attach to a resin bead at a time.

When all the beads have sodium cations attached, the bed is “charged.” When all the beads have calcium anions attached, the bed is “exhausted.”

By the way, cation is pronounced “*Cat-i-on*” and anion is “*Ann-i-on*.”

Some of your customers may be on sodium-restricted diets. Be sure to let your water users know if you use ion exchange water softening. The harder your water, the more sodium is delivered into it for softening.

Potassium chloride (KCl) is available in some areas. It can be substituted for NaCl, but is more expensive and not quite as effective in removing hardness.

### **Inline filtration**

Inline water filters are available in a variety of sizes. They usually have replicable cartridges. They may work well at first, but if left in place beyond their rated capacity, they will turn on you by releasing some of the contaminants previously removed back into the water system. As they foul or clog, water flow may also become restricted.

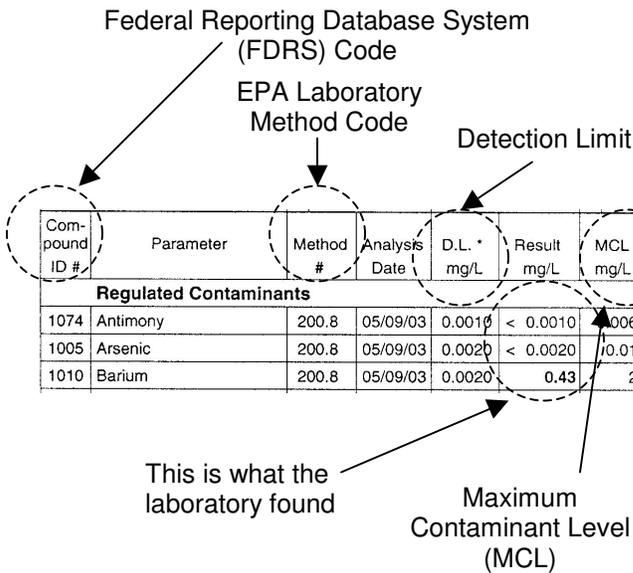
A typical inline filter that can be purchased from local hardware or building supply stores might have a rated capacity of about 16,000 gallons with water having an iron concentration of 5 mg/l. The filter will last for about two months for a family of four. Public water supplies, by definition, have at least 15 service connections. Fifteen people will use up the capacity of an inline filter in about two weeks.

Be sure you buy filters with the capacity to meet your water system needs, and be sure to change the cartridges in accordance with the manufacturer's recommendations.

## Interpretation of chemical and bacteriological sample reports

This is an example of a chemical laboratory report:

Here is how to interpret the report



Indiana Department of Environmental Management  
**OWM - Drinking Water Branch**  
**Inorganic Chemicals in Drinking Water**

Return Completed Form To: Indiana Department of Environmental Management, P.O. Box 7148, Indianapolis, IN 46207-7148  
 Sample Receipt Date: 05/07/03  
 QA Review Date: 05/15/03  
 Report Date: 05/14/03  
 PWSID #: 5225001  
 PWS Facility Name: Town of Akron  
 PWS Address: 305 W. Rochester Street, Akron, IN 46910  
 Laboratory Name: Environmental Health Laboratory  
 Laboratory Certification #: C-71-01  
 Laboratory Report #: 882549-53(49-51)  
 Contact Person: Matt Hayes

Date Sampled: 05/07/03  
 Sample ID #: 882549-51  
 Sample Type:  Routine - Annual,  Routine - Quarterly,  Detection Monitoring,  Confirmation Sample,  Special Purpose  
 Location Code: \_\_\_\_\_  
 Sampling Site: Treatment Plant  
 Comments: \* EHL has demonstrated it can achieve these report limits in reagent water, but all sample matrices.  
 Note: This report may not be reproduced, except in full, without written approval from EHL. EHL is accredited by the National Environmental Laboratory Accreditation Program (NELAP) in accordance with the requirements of your project but has not been processed to comply with NELAP reporting requirements.  
 Does the system chlorinate this water?  Yes  No Was the sample disinfected at the laboratory?  Yes  No

Has this information been sent to IOEM by the laboratory?  Yes  No

Field Treatment:	X	Lead	X	HNO3	X	NHCl	X	Other (explain) Ascorbic Acid	
Compound ID #	Parameter	Method #	Analysis Date	D.L. * mg/L	Result mg/L	MCL mg/L	Compound ID #	Parameter	Method #
<b>Regulated Contaminants</b>									
1074	Antimony	200.8	05/09/03	0.0010	< 0.0010	0.006	1055	Sulfate	300.0
1005	Arsenic	200.8	05/09/03	0.0020	< 0.0020	0.01			
1010	Barium	200.8	05/09/03	0.0020	0.43	2			
1075	Beryllium	200.8	05/12/03	0.0003	< 0.0003	0.004			
1075	Cadmium	200.8	05/09/03	0.0010	0.010	0.005	1052	Sodium	200.7
1020	Chromium	200.8	05/09/03	0.0020	< 0.0020	0.1			
1024	Cyanide (free)	335.4	05/10/03	0.02	< 0.02	0.2			
1025	Fluoride (adjusted)								
1025	Fluoride (natural)	500.0	05/07/03	0.1	0.5	4			
1035	Mercury	245.1	05/13/03	0.0001	< 0.0001	0.02			
1036	Nickel	200.8	05/09/03	0.0010	0.0061	0.1			
1045	Selenium	200.8	05/12/03	0.0020	< 0.0020	0.05			
1085	Thallium	200.8	05/09/03	0.0004	< 0.0004	0.02			
<b>Unregulated Contaminants</b>									
<b>Special Monitoring</b>									
Method #	Analysis Date	D.L. * mg/L	Result mg/L	MCL mg/L					
1040	Nitrate	353.2	05/08/03	0.1	0.3	10			
1041	Nitrite	353.2	05/08/03	0.01	< 0.01	1			
Nitrate + Nitrite		Calc.	05/14/03	---	0.3	10			
Method #	Analysis Date	D.L. * MFL	Result MFL	MCL MFL					
1094	Asbestos					7			

Report Summary: None of the analytes included in the detailed parameter list were detected in the sample submitted for analysis, exceeded, or were equivalent to, their current respective MCLs.

Reviewed by: *Steve Durgin* Date: 5/14/03 Finalized by: *[Signature]*



Sample will not be analyzed if form is not complete.  
Use black ink.  
Laboratory - please send a copy to:

Name: COLUMBIA CITY WATER  
Street: 112 S. CHAUNCEY  
City: COLUMBIA CITY IN (zip) 46725  
Organization Phone Number: 260-248-5118

---

**TO BE COMPLETED BY PUBLIC WATER SYSTEM**

PWSID #: 

5	2	9	2	0	0	4
---	---	---	---	---	---	---

  
County: WHITLEY  
Date: 

0	5	1	0	0	5
---	---	---	---	---	---

  
Time: 

0	8	1	5
---	---	---	---

 Location Code: 

0	0	0	3
---	---	---	---

  
Sampling Location Address: 316 S. TOWNVIEW  
Chlorine Residual at Sampling Address: .65 mg/l  
Printed Name & Initial of Sample Collector  
MAE BLAIN MB

This part of the sampling form is completed by the water system.

Include the system name, address and telephone number.

Be sure to include the Public Water System Identification Number (PWSID) and county.

The location code comes from the water system's site sampling plan (see lesson three).

Include the other required information.

Check the type of sample. If it is a repeat sample, be sure to include the date of the original sample.

Include in the remarks any information that might be useful to the laboratory, like unusual odor, color, etc.

Print name and initial it.

Sample Type (check appropriate square)  
 D-Distribution     C-Repeat     O-Other  
 Date Original Sample Collected (if sample is a repeat) 

--	--	--	--	--	--	--

  
 REMARKS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 Printed Name & Initial of Certified Operator  
Mike Dear  
Mike Dear MD

ANALYSIS DATA - FOR LAB USE ONLY		
<b>TEST: TOTAL COLIFORM</b>		
METHOD*:		
<input type="checkbox"/> MF	<input type="checkbox"/> MPN	<input type="checkbox"/> LST P/A <input checked="" type="checkbox"/> MM P/A <input type="checkbox"/> MM QT
RESULTS:		
<input type="checkbox"/> PRESENT	<input checked="" type="checkbox"/> ABSENT	
Most Probable Number		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Analyst: DT	Date: 5-10-05	Time: 11:10 Am
<b>TEST: <input type="checkbox"/> FECAL COLIFORM <input checked="" type="checkbox"/> E COLI</b>		
METHOD*:		
<input type="checkbox"/> MF	<input type="checkbox"/> MPN	<input type="checkbox"/> LST P/A <input checked="" type="checkbox"/> MM P/A <input type="checkbox"/> MM QT
RESULTS:		
<input type="checkbox"/> PRESENT	<input checked="" type="checkbox"/> ABSENT	
Most Probable Number		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Analyst: DT	Date: 5-10-05	Time: 11:10 Am
<b>HETEROTROPHIC</b>		
PLATE COUNT	/1.0ML	/0.1ML
*If MPN or MMQT is checked, the result is a statistical determination of the most probable number per 100 ml. If MF is checked, the result is organisms per 100 ml. If P/A is checked, the result is present or absent.		

The laboratory fills out this section. This example shows that a test was made for E.Coli and none was found.

If a repeat sample is required, the laboratory will request it here.

The approval and review sections are signed by the laboratory personnel.

REPORT OF SAMPLES	
<input type="checkbox"/>	SUBMIT REPEAT SAMPLES as required under 327 IAC 8-2-8.1
<input type="checkbox"/>	PLEASE SUBMIT ANOTHER SAMPLE. TEST NOT VALID BECAUSE:
<input type="checkbox"/>	Too long in transit (more than 48 hours).
<input type="checkbox"/>	Invalid or no collection date and/or time.
<input type="checkbox"/>	Sample leaked or broken in shipment, insufficient volume.
<input type="checkbox"/>	Residual chlorine present.
<input type="checkbox"/>	Other _____
Approved by:	<u>Paulie Ayala</u>
Reviewed by:	<u>Keith Z. Henley</u>

## Well disinfection

Wells are disinfected to eliminate or reduce many kinds of harmful bacteria and viruses. Disinfection can also reduce harmless bacteria that can cause bad taste and odors. Disinfection will not, however, fix problems with chemical contaminants, pesticides, nitrates, etc.

### When to disinfect

- When coliform bacteria are present
- When water taste or odor changes
- After casing or pump repairs
- After installing new plumbing fixtures
- After flooding of the well
- During startup of seasonal wells
- As part of annual maintenance

### How to disinfect

Here are a few steps that can be used to disinfect a well:

1. Turn off the electrical supply
2. Separate the well from the water system with the isolation valves
3. Remove well cap/seal & move wiring out of the way
4. Mix 1/2 of a gallon of household bleach with 3 gallons water (good for an 4" well, 100 feet deep)
5. Pour mixture into well
6. Turn well on and recirculate water with a garden hose for about two hours after you begin to smell chlorine from the hose
7. If the water runs red (from iron), discard the water somewhere safe (do not run heavily-chlorinated water into your septic system)
8. With the water still recirculating, open a few faucets, hose bibs, etc., until chlorine is detected (use faucets farthest away from the well)
9. Turn off well, recap and let sit for about eight hours
10. Turn on well and run to flush remaining chlorine from the system, running hose somewhere safe to discard the chlorinated water

## Special considerations

- Do not sample for coliform unless total chlorine is absent
- If you cannot sample for chlorine, wait a few days after all chlorine smell is gone before drawing coliform samples
- You may have to repeat the disinfection process one or more times to completely remove all bacteria
- Do not bring heavily chlorinated water into a water softener (too much chlorine can cause damage to the softener)
- Disinfect softeners separately following manufacturer's instructions (usually pouring a ½ cup of bleach into the brine and regenerate)

---

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

To test your comprehension of the material included in lesson five, 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-5 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 5

Check one best answer per question

Question 1.

What is ground water?

- A. The water found in an aquifer
- B. The water found in lakes and streams
- C. The water contained in a ground-level storage tank
- D. The water contained in an elevated storage tank

Question 2.

What is the first step in developing a Wellhead Protection Plan?

- A. Establish a Local Planning Team
- B. Develop a management plan for potential sources of contaminants
- C. Hire a certified professional engineer
- D. Apply to IDEM for a Wellhead Protection permit

Question 3.

What is the maximum average daily pumpage allowed for a water system to use the fixed-radius wellhead protection delineation method?

- A. 25,000 gallons per day
- B. 50,000 gallons per day
- C. 75,000 gallons per day
- D. 100,000 gallons per day

Question 4.

The standard isolation area (sanitary setback) for a well without automatic disinfection is:

- A. 50 feet
- B. 100 feet
- C. 200 feet
- D. 500 feet

Question 5.

With most ion exchange water softeners, what happens to sodium levels in the finished water?

- A. Sodium levels increase
- B. Sodium levels decrease
- C. Sodium levels stay about the same
- D. Sodium is exchanged for copper

Question 6.

Inline water filter elements should be replaced:

- A. Annually
- B. Monthly
- C. In accordance with manufacturer's recommendations
- D. Whenever the filter appears dirty

Question 7.

The symbol "<" means:

- A. More than
- B. Less than
- C. Approximately
- D. Rounder than

Question 8.

Why disinfect a well?

- A. Remove nitrates
- B. Remove pesticides
- C. Soften hard water
- D. Reduce or eliminate harmful bacteria

Question 9.

Coliform samples should be taken from a well immediately after disinfection.

- A. True
- B. False

Question 10.

Water softeners should be disinfected by running heavily-chlorinated water through the softener.

- A. True
- B. False



# Indiana Water Operator Training Manual

## Lesson Six – WT2 operators

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### Contents

Page	2	WT2 systems and operators
Page	2	Chemical feed devices
Page	5	Disinfection
Page	6	Fluoride standardization
Page	7	Water stabilization
Page	7	Monthly Report of Operations
Page	9	Self-graded student examination

## **WT2 systems and operators**

Both water systems and water system operators receive classifications from IDEM. As discussed in Lesson one, a class WT2 (Water Treatment 2) system includes systems with no population limitations that meet the following:

- (A) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (B) Utilize chemical feed to achieve one (1) of the following:
  - (i) Disinfection
  - (ii) Fluoride standardization, or
  - (iii) Water stabilization

A grade WT2 operator is a certified operator qualified to operate a class WT1 and WT2 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; and
  - (iii) interpret chemical and bacteriological sample reports
- (D) Attain one (1) of the following acceptable work experience requirements:
  - (i) One (1) year in the operation of a class WT2 water treatment plant
  - (ii) Two (2) years in the operation of a class WT1 water treatment plant

## **Chemical feed devices**

Dealing with devices that feed chemicals into the water system is a fact of life for many water system operators. Chemicals fed include chlorine, fluoride, potassium permanganate, poly phosphates, lime and others. Most feeders differ from others because the characteristics of chemicals are different.

The design of chemical feeders may vary for the same chemical if that chemical comes in different forms. Chlorine is a good example.

<u>Chemical form</u>	<u>Feeder design</u>
Chlorine pellets	Pellet dropper drops pellets into well
Chlorine tablets	Tablet feeder installs inline and tablets dissolve
Chlorine gas	Tank-mounted feeder on 150 lb. cylinders Manifold wall-mounted feeder for 2,000 lb. cylinders

#### How to calculate chemical feeds

Pounds of Chemical required = Flow (in million gallons per day)  
X 8.34 X desired dosage (in mg/l)

or

Pounds = MGD X 8.34 X mg/l

(8.34 is the weight of a gallon of water)

Don't forget to adjust for chemical concentration. If you use bleach that is five percent chlorine, then it will take 20 pounds of the bleach to get one pound of chlorine.

Let us look at an example:

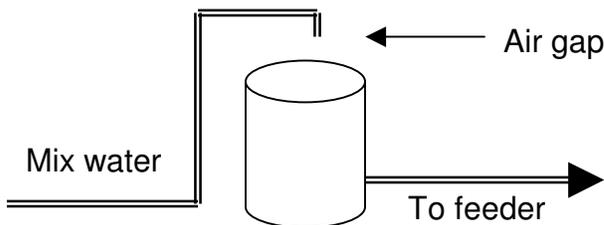
Step 1

Step 2

<p>You want to feed Fluoride at 1 ppm (mg/l)</p> <p>You pump 100,000 gallons per day</p> <p>You are using sodium fluoride (NaF), that is 44% available fluoride (the rest of the compound is sodium)</p> <p>Lbs. = MGD X 8.34 X mg/l</p> <p>Lbs. = .1 X 8.34 X 1</p> <p>Lbs. = .834</p> <p>We still need to factor in the available fluoride</p>	<p>To figure the availability factor, divide 1 by the percentage</p> <p>In this 44% fluoride example,  <math>1/.44 = 2.273</math></p> <p>Multiply the required pounds by the availability factor</p> <p><math>.834 \times 2.273 = 1.896</math> pounds of fluoride solution needed to treat 100,000 gallons of water with a concentration of 1 ppm</p>
--	---

Day tanks

A day tank is a tank that is filled with a chemical mixture that is fed into the water system over a period of time.



In the previous example, NaF was used. It is usually mixed at about 2%.

This day tank holds about 100 gallons

20 pounds into 100 gallons = 2.4%

Remember, 100 gallons of water weighs 834 lbs.

$20 \div 834 = .0239$

With a NaF concentration of 2.4% and an availability of 44% F, there are .088 lbs. of F in each gallon of the day tank solution. ( $.024 \times .44 \times 8.34 = .088$ ). 1.896 lbs. of F are needed to treat 1,000,000 gallons of water in a day.  $1.896 \div 24 = .079$  lbs. per hour. If the feed pump is set at a rate of .015 gpm, it will deliver 21.6 pounds of solution per day. ( $.015 \times 60 \times 24 = 21.6$ ).  $21.6 \times .088 = 1.9$  lbs.

## Disinfection

Disinfection can reduce or eliminate many pathogens. It provides some protection from cross connections and may assist in filtration. Automatic disinfection can reduce the isolation area (sanitary setback) from 200 feet to 100 feet.

Generally, chlorine is the most practical method for disinfection. Choices for chlorine include gas, bleach, powder and tablets. Other common options for disinfection include ultra violet (UV), ozone and hydrogen peroxide.

### Chlorine (Cl<sub>2</sub>) characteristics

- Chlorine is a toxic, yellow-green gas
- Heavier than air (2 ½ times)
- Highly reactive
- Iron ignites when heated in a chlorine atmosphere
- When pressurized, Cl<sub>2</sub> is a liquid
- Used as a weapon in WWI, killing nearly 2,000 and injuring over 164,000
- People can smell Cl<sub>2</sub> at 0.02 ppm
- 1,000 ppm (0.1%) will kill you in a couple of deep breaths

In drinking water, chlorine is measured as free and total. Free chlorine is the concentration of residual chlorine in water present as dissolved gas (Cl<sub>2</sub>), hypochlorous acid (HOCl) and/or hypochlorite ion (OCl<sup>-</sup>). Total chlorine is free chlorine plus combined chlorine. Combined chlorine is also known as chloramines and is often referred to as a spent bullet.

Always maintain a free chlorine residual at all points in the water system of at least .25 mg/l and no less than 1 mg/l total chlorine throughout the system. If .25 mg/l free chlorine cannot be obtained without going a lot over 1 mg/l total chlorine, say > 2 mg/l, look into possible problems such as iron bacteria, ammonia or other organics.

## Fluoride standardization

Fluoride is a naturally occurring element found to be beneficial in reducing tooth decay. According to the Indiana State Department of Health, people who drink optimally fluoridated water from birth will experience approximately 20-40 percent less tooth decay in their lifetime. A desirable concentration of fluoride is .8 to 1 mg/l. Some water systems already have some fluoride in their water, so be sure to determine your water supply's natural fluoride concentration before starting a fluoride program.

The U.S. EPA has set a maximum primary standard of 4 mg/l, above which fluoride may cause some bone diseases. There is a secondary standard of 2 mg/l, above which there may be a brown staining and/or pitting of the permanent teeth. Children under 9 should not drink water with a concentration greater than 2 mg/l fluoride.

### Types of fluoride

- Sodium Fluoride (NaF)
  - Dry
  - Fairly easy to mix
  - Most expensive
  - Breathing hazard
- Sodium Silicofluoride (Na<sub>2</sub>SiF<sub>6</sub>)
  - Dry
  - Harder to mix
  - Less expensive than NaF
  - Breathing hazard
- Hydrofluosilicic acid (H<sub>2</sub>SiF<sub>6</sub>)
  - Liquid
  - Easiest to mix
  - Lowest cost
  - Very reactive (never mix with bleach)

Know the naturally occurring concentration of fluoride in your water supply before starting a fluoride program. Be sure to factor in the availability of fluoride in your fluoride compound when calculating dosages.

## **Water stabilization**

Water stabilization is the addition of chemicals to a water system to inhibit the precipitation (dropping out of solution) of minerals. Stabilization chemicals can keep minerals such as iron and manganese in solution to prevent “red water.”

Water treatment chemicals can control build of scales within pipes by distorting crystalline formations so minerals do not stick to the inside of the pipes. This is sometimes called deflocculation.

Corrosion can sometimes be controlled through water stabilization. Chemicals can reduce the migration of metal ions into the water from surrounding pipes. This can assist in resolving copper and lead problems.

Some companies may claim their products will cure all water problems. Protect yourself and customers by performing laboratory testing with product samples on your water (jar testing). Discuss the problem with multiple suppliers and order only small amounts of the product for initial trial before committing to full-scale implementation. Ask your IDEM inspector for advice before commencing a water stabilization program.

## **Monthly Report of Operations**

All community public water supplies that add chemicals to their water are required to make daily entries onto a monthly report of operations (MRO). The certified operator-in-charge must sign the report and submit the MRO to IDEM within 10 days following the end of each month.

In addition to reporting amounts of chemicals added, the operator must record the results of routine testing for Turbidity, Chlorine residuals (both plant and distribution system) and other common water characteristics.

Filter runs and backwash water used should be recorded, as should total plant production and minimum, maximum and average daily pumpage.

All water systems should record total well production and minimum, maximum and average daily pumpage, even if not required to submit MROs.

This practice can provide documentation for fixed-radius Wellhead Protection Plans and significant withdrawal reports to the Indiana Department of Natural Resources (DNR).

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

To test your comprehension of the material included in lesson six, 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-6 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 6

Check one best answer per question

Question 1.

A pellet dropper is designed to drop chlorine pellets into:

- A. Wells
- B. Day tanks
- C. Elevated storage tanks
- D. Ground level storage tanks

Question 2.

Liquid chlorine is often shipped in:

- A. 1 ton cylinders
- B. 2,000 pound cylinders
- C. 150 pound tanks
- D. All of the above

Question 3.

You have bleach solution that is 5% chlorine. How many pounds of the bleach solution do you need to get 1 pound of chlorine?

- A. 2 pounds
- B. 12 pounds
- C. 20 pounds
- D. 22 pounds

Question 4.

A day tank is used for:

- A. Premixing chemicals for feeding into the water system
- B. Storage of non-water treatment chemicals within an isolation area
- C. Testing water stabilizers in a laboratory
- D. None of the above

Question 5.

You should maintain a free chlorine level of at least what in your water system:

- A. 1 mg/l
- B. .25 mg/l
- C. 1.25 mg/l
- D. 2.5 mg/l

Question 6.

If you suspect a chlorine leak, you should drop to the floor and crawl away from the area.

- A. True
- B. False

Question 7.

Fluoridation of public water supplies serving more than 50,000 persons is required by the Indiana State Department of Health.

- A. True
- B. False

Question 8.

Children under 9 years of age should not drink water with a fluoride concentration greater than:

- A. .5 mg/l
- B. 1 mg/l
- C. 1.5 mg/l
- D. 2 mg/l

Question 9.

What mineral in a water supply may cause red water?

- A. Copper
- B. Lead
- C. Calcium Carbonate
- D. Iron

Question 10.

Corrosion is:

- A. The buildup of crystalline mineral formations
- B. The accumulation of copper and lead in a water heater
- C. The migration of metal ions into water from surrounding pipes
- D. The primary cause of mud balls in a pressure filter



# Indiana Water Operator Training Manual

## Lesson Seven – WT3 operators

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### Contents

Page	2	WT3 systems and operators
Page	3	Filtration
Page	4	Gravity filters
Page	5	Pressure filters
Page	6	Lime soda softening
Page	7	Reverse osmosis
Page	9	Advanced ion exchange softening
Page	11	Self-graded student examination

## **WT3 systems and operators**

A class WT3 (Water Treatment 3) system includes systems that meet the following:

- (A) Acquire water from one (1) of the following:
  - (i) Ground water
  - (ii) Purchase
- (B) Utilize chemical feed
- (C) Have one (1) of the following:
  - (i) Pressure or gravity filtration
  - (ii) Ion exchange processes if the population served is greater than five hundred one (501)
  - (iii) Lime soda
  - (iv) Reverse osmosis

A grade WT3 operator is a certified operator qualified to operate a Class WT1, WT2 and WT3 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; and
  - (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 WT3 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

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

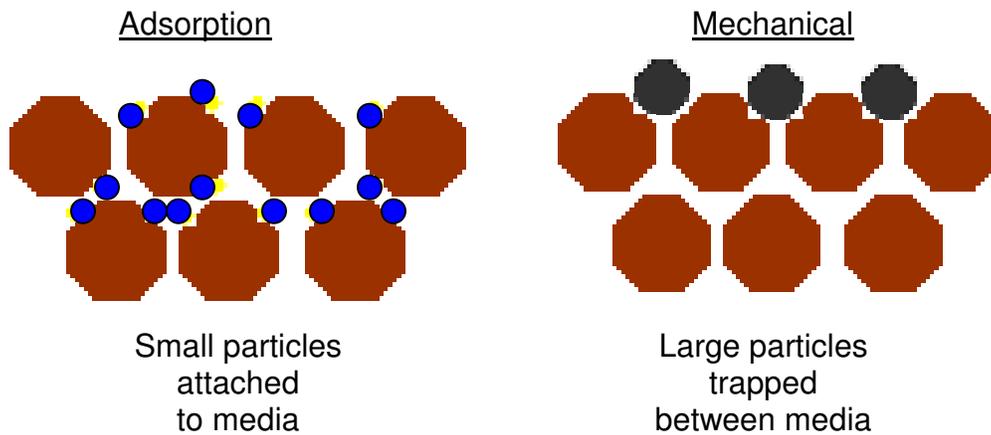
(ii) transfer an OIT certification to a water treatment plant or distribution system with a public water system identification number (PWSID) different than the PWSID for which the certification was issued;

(iii) hold two (2) treatment plant or distribution system OIT certifications concurrently; or

(iv) renew the OIT certification

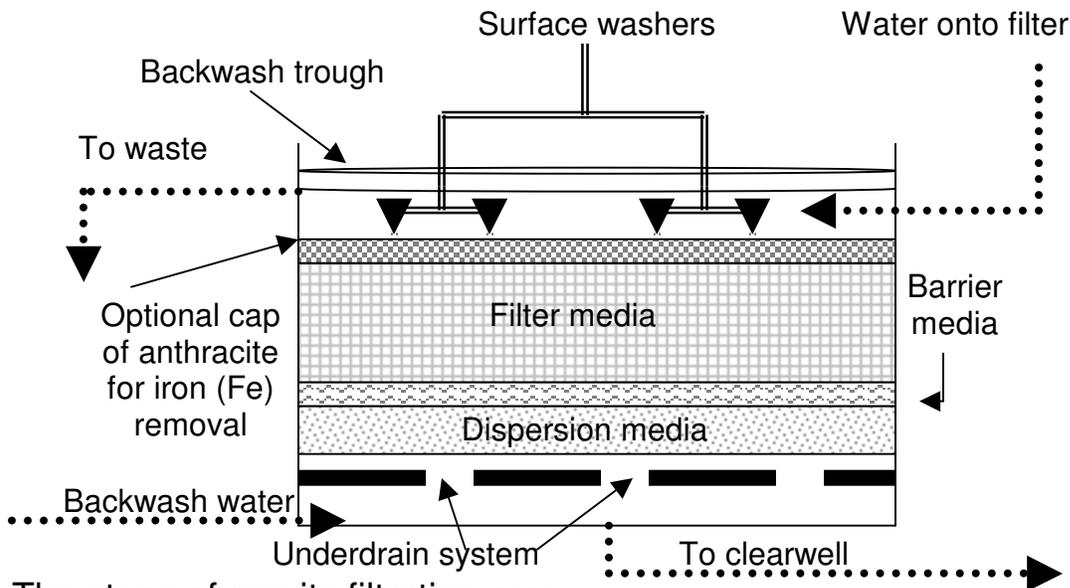
## **Filtration**

Both gravity and pressure water treatment filters work using the same principles. Water flows through a media mixture (usually sand) and particles suspended in the water either attach to the irregular surfaces of the media by adsorption, or the particles are trapped between media by mechanical means. The following drawings illustrate the two types of filtration.



## Gravity filters

Gravity water treatment filters are usually found in larger treatment facilities. Here is a typical diagram:



The steps of gravity filtration are:

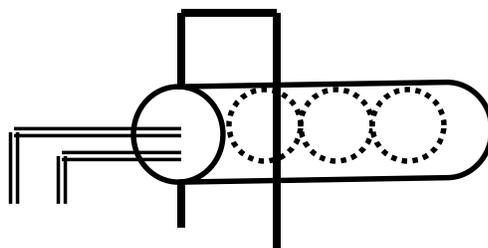
1. Turn on the water and allow it to flow onto the filter at a rate of about two gallons per minute per square foot of media surface area.
2. If possible, waste the filtered water at the beginning of the filter run because the first few minutes of the run often produce somewhat turbid water (turbidity spike).

3. As the filter accumulates contaminants, the water level will rise due to the build-up of particles from adsorption and mechanical filtration. This is called “head loss.” Operating experience will determine the head loss point at which the filter should be backwashed (cleaned).
4. When the need for backwashing is observed, turn off the incoming water and allow the filter to drain.
5. Close the filter drain and, if equipped with surface washers, run them for a few minutes to break up the particles trapped at the surface of the filter.
6. Introduce clean (previously treated) water to the bottom of the filter at a rate-of-flow sufficient to expand the filter media by about 20-25%. The backwash water will flow into the backwash trough to waste. Again, operating experience will determine how long to backwash.
7. Allow the filter to rest unused for an hour or more before placing it back into service.

## **Pressure filters**

Pressure filters work very much like gravity filters, but pressure filters, as the name implies, are fully enclosed and operated under pressure.

Vertical pressure filters are usually, but not always, fairly small (say, four to eight feet high). These compact units are well suited for smaller water systems and lend themselves to easy expansion. Horizontal pressure filters often are found in larger water systems. These filters can be quite large (20 or more feet long) and can be located with the piping inside a building and the rest of the structure outside of the building. There may be multiple filter cells within a single tank.



While similar in design and operation to gravity filters, pressure filters can operate at much higher rates-of-flow than gravity filters. Filter flows of six to 12 gallons per minute per square foot of media surface area are not uncommon, but vary by manufacturer.

Backwash rates for pressure filters vary between manufacturers. It is important to follow the backwash instructions provided by the filter manufacturer or design engineer.

For both gravity and pressure filters, it is important to note that lower water temperatures require lower backwash rates, and higher water temperatures require higher backwash rates. Remember, colder water is denser than warmer water.

### **Lime soda softening**

As previously discussed in lesson five of this manual, hard water has calcium (Ca) or magnesium (Mg) ions in it. Usually we measure hardness as calcium carbonate (CaCO<sub>3</sub>). It is a molecule made of one atom of calcium, one atom of carbon (C) and three atoms of oxygen. Hardness is usually measured in milligrams per liter (mg/l) or grains per gallon (GPG).

Hardness as calcium carbonate

	<i>mg/l</i>	<i>GPG</i>
Soft water	0-17	0.0-1.0
Moderately hard water	60-120	3.5-7.0
Very hard water	180 & over	10.5 & over

(1 GPG = 17.1 mg/l)

There are two kinds of water hardness. Carbonate hardness is known as temporary hardness. Heating water causes precipitation (dropping out of solution) of carbonate hardness. It is one of the reasons why water heaters get deposits at the bottom.

Non-carbonate hardness is permanent and heating water does not affect it. Non-carbonate hardness comes from sulfates and chlorides of calcium and magnesium in water.

Lime soda softening is a two-stage process and is used to reduce the hardness of very hard water. Water with 35-40 grains per gallon (GPG) can be reduced to a hardness of 5-10 GPG. Slake lime [Ca(OH)<sub>2</sub>] can be added to hard water to precipitate the carbonate hardness. Filtration, clarification, settling, etc., can remove the precipitate.

Soda ash (Na<sub>2</sub>CO<sub>3</sub>) is added after the reduction of carbonate hardness and the non-carbonate hardness precipitates and, again, can be removed by filtration, clarification, settling, etc.

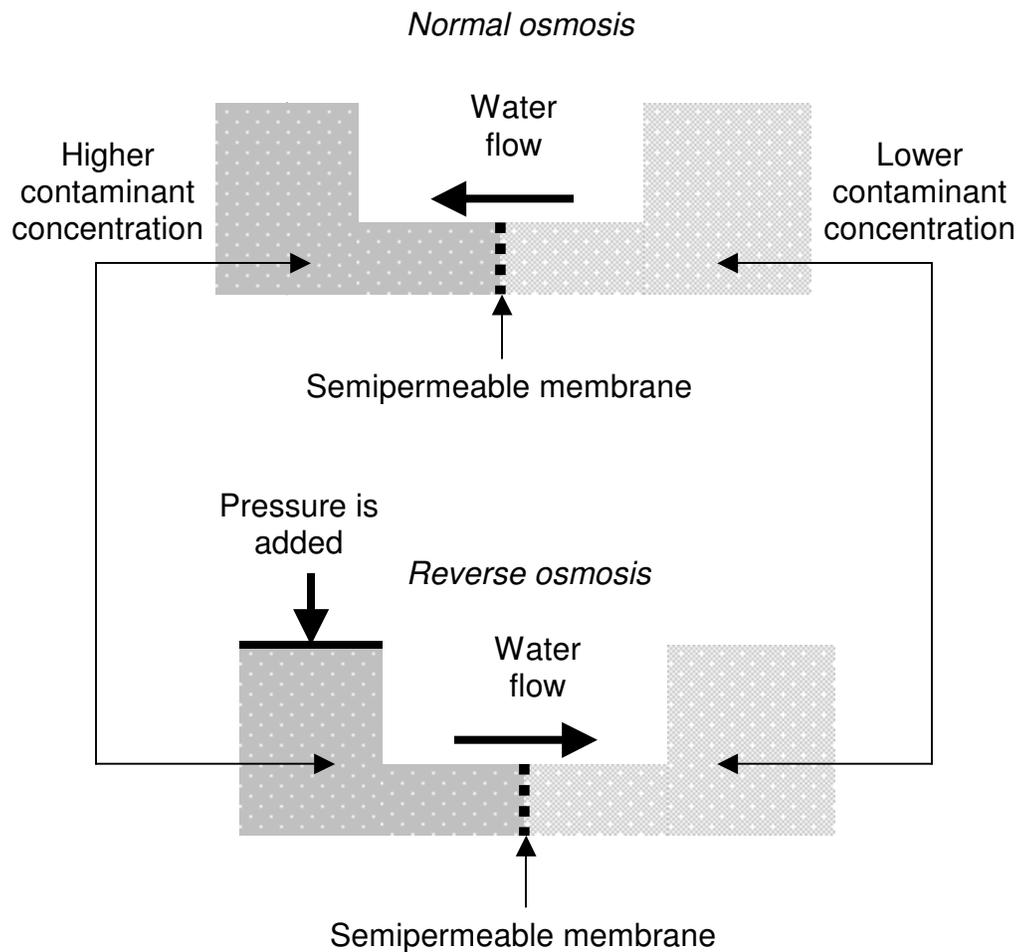
Lime soda softening requires large settling tanks and has pros and cons:

Advantages	Disadvantages
<ul style="list-style-type: none"><li>➤ Reduction of some total dissolved solids</li><li>➤ Taste and odor improvements</li><li>➤ Removal of:<ul style="list-style-type: none"><li>○ Iron</li><li>○ Arsenic</li><li>○ Heavy metals</li></ul></li></ul>	<ul style="list-style-type: none"><li>➤ Requires pH adjustments</li><li>➤ Systems hard to operate and control</li><li>➤ Sludge disposal a problem</li></ul>

## Reverse osmosis

According to Dictionary.com, osmosis is the diffusion of fluid through a semipermeable membrane from a solution with a low solute concentration to a solution with a higher solute concentration until there is an equal concentration of fluid on both sides of the membrane. Reverse osmosis is a method of producing pure water by forcing saline or impure water through a semipermeable membrane across which salts or impurities cannot pass.

Sometimes a couple of pictures are better than 69 big words.



As is the case with most water treatment methods, there are a variety of considerations to be made when choosing reverse osmosis.

Reverse osmosis can reduce:

- Arsenic
- Asbestos
- Fluoride
- Herbicides
- Lead
- Mercury
- Nitrate
- Pesticides
- Radium
- Salt

Semipermeable membranes are fragile:

- Hard water can clog membrane
- Chlorine can destroy membrane
- Membrane must be rinsed regularly to prevent scaling
- Prefiltration is usually required

## **Advanced ion exchange softening**

Advanced ion exchange softening at water treatment plants works much like a basic ion exchange softener, but on a larger scale. Undesirable hardness ions are exchanged for more desirable ions. Various types of chemicals and resins may be used, depending upon the manufacturer's design.

Many advanced ion exchange softening units are fairly small, like vertical pressure filters, and can be combined for increased capacity.

Advanced ion exchange softening is best used for additional softening following lime-soda softening, or treating water that is not too hard to begin with, say less than (<) 10 GPG.

This type of softening has little effect on the pH of water. Some types of softeners may add salt to water, which is undesirable for people with certain health conditions.

Ion exchange should not be used when the concentration of iron (Fe), manganese (Mn) or the combination of the two exceeds 0.3 mg/l. Ion exchange should not be used on raw or wash waters containing (*high*) dissolved oxygen.

Most deep well waters are fairly low in dissolved oxygen (DO). Shallow wells may have higher DO. In low DO water, Fe and Mn are soluble and remain dissolved in the water. Water softeners will remove some soluble Fe and Mn.

In high DO water, Fe and Mn become insoluble, are no longer dissolved, and become visible as red colored and staining. Water softeners will become clogged from insoluble Fe and Mn. Prefilters ahead of the softener are necessary to remove Fe and Mn in high DO situations.

Sometimes water system customers may complain of a thin black sludge or oily sheen on top of their coffee or tea. Fe and/or Mn reacting with the tannins and acids in beverages often cause this condition. These complaints are a good indicator that Fe and/or Mn are slipping through the water treatment system.

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

To test your comprehension of the material included in lesson seven, 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-7 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 7

Check one best answer per question

Question 1.

Water filtration removes impurities by what means?

- A. Adsorption
- B. Mechanical
- C. Ion exchange
- D. Both A and B above

Question 2.

Anthracite (coal) cap layers are used in water filters to assist in the removal of what?

- A. Oxygen (O<sub>2</sub>)
- B. pH (0-14)
- C. Hydrogen (H)
- D. Iron (Fe)

Question 3.

Media expansion is the best guide for backwashing pressure filters.

- A. True
- B. False

Question 4.

Lime-soda softening lowers the pH of water it treats.

- A. True
- B. False

Question 5.

Reverse osmosis can reduce levels of:

- A. Arsenic
- B. Lead
- C. Pesticides
- D. All of the above

Question 6.

Semipermeable membranes are used in reverse osmosis because they are tough and can take a lot of abuse.

- A. True
- B. False

Question 7.

Your water system water is very hard (>40 GPG). Which is not a good choice for softening the water?

- A. Reverse osmosis
- B. Ion exchange
- C. Lime-soda
- D. None of the above

Question 8.

In normal operation (treatment mode), a household water softener, like the ones to the right, work by:

- A. Exchanging salt for hardness
- B. Exchanging hardness for salt
- C. Filtering out hardness
- D. All of the above



Question 8.

Question 9.

High dissolved oxygen in the raw water improves the operation of ion exchange water softeners.

- A. True
- B. False

Question 10.

Reading tea leaves can be fun. Can you learn anything about your water quality from your customer's tea?

- A. Yes
- B. No



# Indiana Water Operator Training Manual

## Lesson Eight – WT4 operators

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### Contents

Page	2	WT4 systems and operators
Page	3	Surface water
Page	5	Ground water under the direct influence of surface water
Page	6	Coagulation and flocculation
Page	10	Self-graded student examination

## **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).

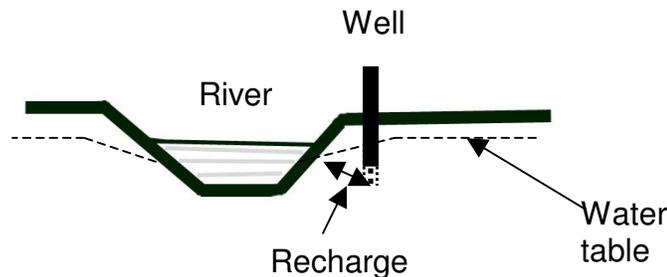
Colder water is denser than warmer water. When treating cold water, most processes slow down. Flocculation and settling go more slowly and chemical reactions take more time. Changes in source water temperature often require changes in the water treatment process that would not otherwise be required if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



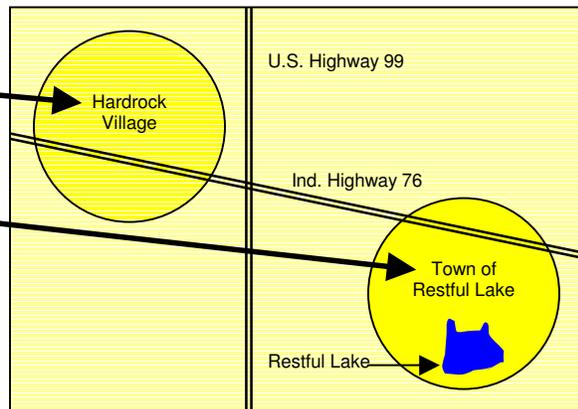
Question 9.

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



# OWQ Drinking Water Inspection Areas - 2005

## Drinking Water Inspectors

- KEN BROWN
- CAROLYN CHAPPELL
- PAUL DICK
- SHAWN FLANINGAM
- CHRIS HOESLI
- KIRK KUROIWA
- CRAIG LAWSON
- PAUL MAHONEY
- BILL MORGAN
- DAN PLATH
- TAMARA RATLIFF-ROBERTS
- LUCIO TERNIEDEN

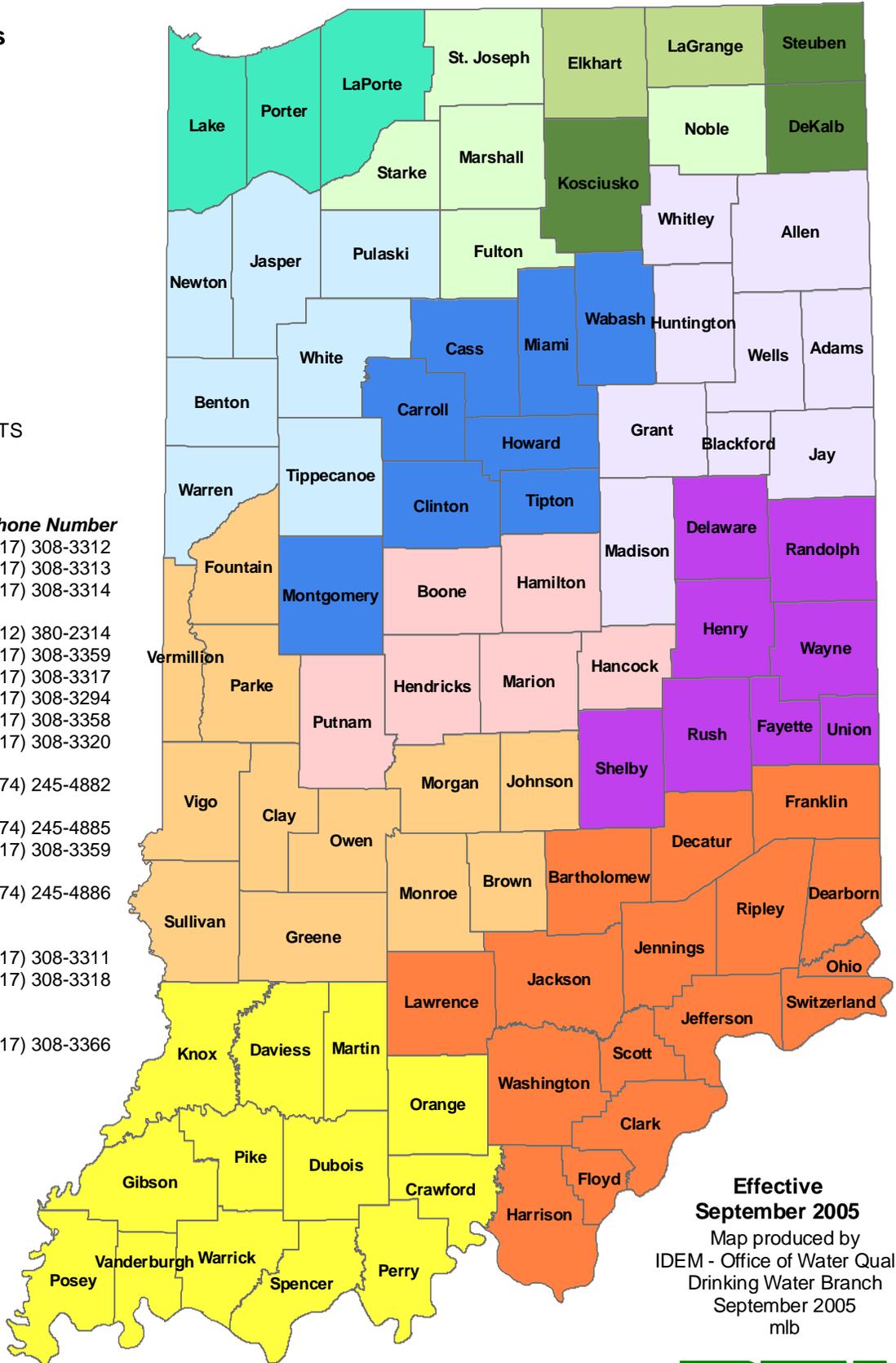
<i>Name</i>	<i>Phone Number</i>
Ken Brown	(317) 308-3312
Carolyn Chappell	(317) 308-3313
Paul Dick	(317) 308-3314
Shawn Flaningam	
Southwest Office	(812) 380-2314
Indianapolis Office	(317) 308-3359
Chris Hoesli	(317) 308-3317
Kirk Kuroiwa	(317) 308-3294
Craig Lawson	(317) 308-3358
Paul Mahoney	(317) 308-3320
Bill Morgan	
North Office	(574) 245-4882
Dan Plath	
North Office	(574) 245-4885
Tamara Ratliff-Roberts	(317) 308-3359
Lucio Ternieden	
North Office	(574) 245-4886

<i>Senior Environmental Managers</i>	
Wayne Brattain	(317) 308-3311
Larey Conquergood	(317) 308-3318

<i>Section Chief</i>	
Liz Melvin	(317) 308-3366

**Mailing Address:**  
 Mail Code 66-34  
 IDEM - Office of Water Quality  
 Drinking Water Branch  
 Field Inspection Section  
 100 North Senate Avenue  
 Indianapolis, IN 46204

**Physical Address:**  
 Drinking Water Branch  
 2525 North Shadeland Avenue  
 Indianapolis, IN 46219



**Effective September 2005**  
 Map produced by  
 IDEM - Office of Water Quality  
 Drinking Water Branch  
 September 2005  
 mlb



Please note that this information changes from time to time.  
 Go to this Website for the latest information:  
<http://www.in.gov/idem/water/dwb/fldinsp/dwinspmap.pdf>  
 Appendix A1

### **Drinking Water Branch**

(All numbers are 317 area code, unless otherwise indicated)

Pat Carroll, Branch Chief, 308-3281

Reggie Baker, Counter-Terrorism & Security Coordinator, 308-3332

Stacy Jones, Regulatory Development, 308-3292

Marc Hancock, Compliance Assistance 308-3113

Rick Miranda, Special Projects, 308-3300

Steve Vaughn, File Room, 308-3278

Fax Number, 308-3339

#### **Compliance Section**

Al Lao	Section Chief	308-3283
Janet Matthews	Secretary	308-3282
	Fax Number	308-3340
Sandra DeCastro		308-3295
Sara Pierson		308-3298
David Forsee		308-3288
Amy Jani		308-3139
Adrian Lugo-Martinez		308-3285
Bridget Murphy		308-3286
George Neely		308-3291
Lilia Park		308-3297
Peter Poon		308-3328
Jane Servies		308-3337
Laura Spriggs		308-3160
Mehul Sura		308-3303
April Swift		308-3290
Frank Velikan		308-3160
Wayne Wang		308-3296
Jennifer Wingstrom		308-3287

#### **Permit, Certification & Capacity Section**

Mary Hollingsworth	Section Chief	308-3331
Linda Smothers	Secretary	308-3299
Theresa Anderson		308-3230
Arnold Bockrand		308-3302
Linda Edwards		308-3159
Denny Henderson		308-3304
Phil Hiestand		308-3284
Mary Hoover		308-3393
Judy Kennedy		308-3321
Ruby Keslar		308-3305
Daniel Mains		308-3307
Romy Manalo		308-3306
Heidi Nassiri		308-3362

Field Inspection Section

Liz Melvin	Section Chief	308-3366
Virginia Harris	Secretary	308-3308
Wayne Brattain		308-3311
Ken Brown		308-3312
Carolyn Chappell		308-3313
Larey Conquergood		308-3318
Jim Davis		308-3316
Paul Dick		308-3314
Shawn Flaningam	(812) 380-2314 (SW Office)	
Chris Hoesli		308-3317
Kirk Kuroiwa		308-3294
Craig Lawson		308-3358
Paul Mahoney		308-3320
Bill Morgan	(574) 245-4882 (N Office)	
Dan Plath	(574) 245-4885 (N Office)	
Lucio Ternieden	(574) 245-4886 (N Office)	

Ground Water Section

Jim Sullivan	Section Chief	308-3388
Virginia Harris	Secretary	308-3308
Matthew Baller		308-3323
Mitt Denney		308-3324
Jim Harris		308-3325
Gregg Lemasters		308-3327
Lance Mabry		308-3319
Tamara Ratliff-Roberts		308-3326
Mike Yarling		308-3330

Please note that the above persons and telephone numbers change from time to time. Go to this Website for the latest information:  
<http://www.in.gov/idem/water/phone.html>

Indiana Administrative Code 327 Article 8 specifies the rules for public water supplies. To view 327 IAC 8, go to the following Website:  
<http://www.in.gov/legislative/iac/T03270/A00080.PDF>

US Environmental Protection Agency Contacts



**EPA Headquarters**

**Standard Mailing Address**  
 Environmental Protection Agency  
 Ariel Rios Building  
 1200 Pennsylvania Avenue, N.W.  
 Mail Code 3213A  
 Washington, DC 20460  
 (202) 260-2090

**Overnight Package Delivery Mailing Address**  
 Environmental Protection Agency  
 EPA East  
 1201 Constitution Avenue, N.W.  
 Room number 4101 M  
 Washington, DC 20004

National Response Center (report oil and chemical spills) 800-424-8802  
 Safe Drinking Water Hotline 800-426-4791

**Office of Ground Water & Drinking Water**

<p><b>Mailing address:</b>                  Ariel Rios Building                  1200 Pennsylvania Avenue, NW                  Washington, DC 20460-0003</p>	<p><b>Street address:</b>                  EPA East                  1201 Constitution Ave, NW                  Washington, DC 20460-0003</p>
<p>Phone: 202-564-3750                  Fax: 202-564-3753 (Director's office)                  Fax: 202-564-3751 (Drinking Water Protection Division)                  Fax: 202-564-3752 (Standards and Risk Management Division)</p>	<p>Technical Support Center:                  U.S. EPA                  26 Martin Luther King Drive                  Cincinnati, Ohio 45268                  Phone: 513-569-7948                  Fax: 513-569-7191</p>

## Region 5 U.S. EPA

(Serves Indiana, Illinois, Michigan, Minnesota, Ohio and Wisconsin)

Regular or certified mail address: US EPA Region 5 77 W. Jackson Blvd. Chicago, IL 60604	Phone: 312-353-2000 Toll-free: 800-621-8431
<b>Ground Water &amp; Drinking Water Organization and Contacts</b>	
GWDW Immediate Office  Branch Chief Charlene Denys, 312-886-6206 Deputy Branch Chief Thomas Poy, 312-886-5991 Program Planning Nicholas Damato, 312-886-0190 Secretary Veronica Terrell, 312-353-8842 Student Aide Ebony Robinson, 312-353-6266	Enforcement Program  Program Leader Ray Urchel, 312-886-6292 Senior Enforcement Officer Tom Murphy, 312-886-9546 Enforcement/Compliance Specialist Denise E. Young, 312-886-4241 Enforcement/Compliance Specialist Annie Hawkins, 312-353-8807 Enforcement/Compliance Specialist LaYvette Collymore, 312-353-4416 Enforcement Support Odessa Howard, 312-886-4238
Data Management and Technical Support Program  Program Leader/Wellhead Protection Rita Bair, 312-886-2406 Source Water Protection Bill Spaulding, 312-886-9262 Regulations Miguel Del Toral, 312-886-5253 Quality Assurance/Laboratory Certification Patrick Churilla, 312-353-6175 SDWIS/Fed Data Management Kris Werbach, 312-886-6527 Health Effects Kim Harris, 312-886-4239 Drinking Water Treatment Ron Kovach, 312-886-1441 SDWIS/Fed Data Management Support Thao Nguyen, 312-886-6693	State Program Development and Implementation  Program Leader Janet Kuefler, 312-886-0123 Indiana Program Manager Margarita Chacon, 312-886-0225

## Other Sources of Drinking Water Information

The following organizations and associations may be able to assist you in finding information about drinking water.



### Indiana

Indiana Section AWWA  
Tim Bumgardner  
2984 Crestwood Lane  
Danville, IN 46122

317-745-1124  
<http://www.inawwa.org>

Indiana Rural Water Association  
PO Box 679  
Nashville, IN 47448-0679

812- 988-6631  
<http://www.indianaruralwater.org>

Indiana Water Operator Training  
Website

<http://www.indianawateroperatortraining.org>

Alliance of Indiana Rural Water  
P.O. Box 428  
Beech Grove, IN 46107

317-789-4200  
<http://www.inh2o.org>

Indiana Association of Cities and  
Towns  
200 S. Meridian St., Suite 340  
P.O. Box 1903  
Indianapolis, IN 4620-1903

317-237-6200  
<http://www.citiesandtowns.org>

## National

American Water Works Association 6666 W. Quincy Ave. Denver, CO 80235	303-794-7711 <a href="http://www.awwa.org">http://www.awwa.org</a>
National Drinking Water Clearinghouse National Environmental Services Center Box 6064 West Virginia University Morgantown, WV 26506-6064	800-624-8301 <a href="http://www.nesc.wvu.edu/ndwc">http://www.nesc.wvu.edu/ndwc</a>
National Ground Water Association 601 Dempsey Road Westerville, OH 43081	800-551.7379 <a href="http://www.ngwa.org">http://www.ngwa.org</a>
National Rural Water Association 2915 South 13th Street Duncan, OK 73533	580-252-0629 <a href="http://www.nrwa.org">http://www.nrwa.org</a>
U.S. Department of Agriculture Rural Utilities Service 1400 Independence Ave., SW Washington, DC 20250	202-690-2670 <a href="http://www.usda.gov/rus/water/index.htm">http://www.usda.gov/rus/water/index.htm</a>
U.S. Environmental Protection Agency Water Division (WG-15J) US EPA Region 5 77 W. Jackson Blvd. Chicago, IL 60604-3590	312-886-6206 <a href="http://www.epa.gov/region5/water/gwdw">http://www.epa.gov/region5/water/gwdw</a>



# Cross Connection Drinking Water Branch Fact Sheet

***What is a cross connection?***

A cross connection is defined as any physical arrangement whereby a public water supply is connected, directly or indirectly, with any secondary water supply system, sewer drain, conduit, pool, storage reservoir, plumbing fixture, boilers or other device which contains or may contain any water, contaminated liquid, or other waste of unknown or unsafe quality that could impart a contaminant to the drinking water as a result of backflow or backsiphonage.

***What did you mean by backflow or backsiphonage?***

Backflow is a reverse flow condition, created by difference in water pressures, which causes water to flow back into the distribution pipes of a potable water supply from any source or sources other than an intended source. Backsiphonage is a form of backflow caused by a negative or below atmospheric pressure within a water system.

***What could happen if my system has a cross connection?***

A number of diseases are known to be carried by or spread by water. Several of these diseases have been traced to water contamination through cross connection. Some of the diseases caused by cross connection problems were Typhoid Fever, Salmonellosis, Polio, Hepatis, Brucellosis Dysentery and Gastroenteritis. Beside diseases, your water could be contaminated from cross connection with chemicals. Chemicals such as fertilizers, pesticides, and herbicides can contaminate public water supplies because they are often mixed with water for spraying operations.

***How do I know if I have a cross connection problem?***

An inspection of your water system is an easy way to check for cross connections. IDEM recommends that the inspection be performed by an individual certified in the state of Indiana as a backflow prevention inspector/tester or someone familiar with plumbing and backflow hazards. IDEM's permit section has a list of all certified backflow inspectors.

***What are my legal responsibilities as a public water supplier?***

The passage of the Safe Drinking Water Act has made public water systems responsible for the quality of water at the consumer's tap. Therefore all public water systems should maintain an active cross connection control program.

***How do I develop a cross connection control program?***

An effective cross connection program has the following elements, but are not limited to these elements:

- Establish a cross connection control ordinance.
- Conduct educational and informative meetings defining the cross connection control program.
- Systematic inspection of new and existing installations to you water system.
- Keep records on all the cross connection control devices.

***Who do I contact if I have any question?***

You should contact the *IDEM Drinking Water Branch*, if you have any question. Our number is 317-308-3308. You may contact the *IDEM Environmental Helpline* at 800-451-6027 and ask them to connect you with 308-3308, or call the *EPA Safe Drinking Water Hotline* at 800-426-4791.

***Rule Citations***

170 IAC 6-1-20, 327 IAC 8-10-1, 327 IAC 8-10-2, 327 IAC 8-10-3, 327 IAC 8-10-4, 327 IAC 8-10-5, 327 IAC 8-10-6, 327 IAC 8-10-7, 327 IAC 8-10-8, 327 IAC 8-10-9, 327 IAC 8-10-10, 327 IAC 8-10-11, 675 IAC 16-1.2-35.1 Section P-1505 12.

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## Indiana Certified Laboratories

The Indiana State Department of Health (ISDH) Laboratories are responsible for certifying laboratories under the Safe Drinking Water Act. Both microbiological and chemistry laboratories may be certified by ISDH.

Because the status of certified laboratories changes frequently, it is recommended that the following Websites be visited to obtain the latest information:

Certified microbiological laboratories

<http://www.in.gov/isdh/labs/micro2001.htm>

Certified chemistry laboratories

<http://www.in.gov/isdh/labs/chem2001.htm>

You may also obtain information by telephone by calling:

Certified microbiological laboratories

317-233-8072 (ISDH)

Certified chemistry laboratories

317-233-8071 (ISDH)

or,

Indiana Department of Environmental Management (IDEM)

Drinking Water Branch

Sandra DeCastro, Compliance Section

317-308-3295



# Public Notification Fact Sheet

***What is Public Notification?***

Public notification is the process which public water systems use to inform their customers when a violation of a drinking water regulation has occurred. Public notification is required by law, as specified by the federal Safe Drinking Water Act and Indiana state law (327 IAC 8-2).

***Why is Public Notification Important?***

Public notification is an important way in which public water systems are able to provide information to their customers regarding their drinking water supply. The types of information that a public notification may provide include: 1) violations of regulations and standards, 2) explaining the duration and frequency of a problem, 3) warning about potential adverse health effects, 4) the need for alternate water supply, if appropriate, 5) steps being taken to correct the violation, 6) the possible need for system improvements.

***Who Needs to Provide Public Notification?***

All public water systems (community, nontransient noncommunity, and transient noncommunity) must provide public notification when violations of drinking water regulations occur.

***When Must Public Notification Be Given?***

Public water systems must provide public notification whenever they are in violation of a drinking water regulation. How quickly public notification must be provided and the duration of the public notification depends on the type of violation. For example, public notification for violation of maximum contaminant levels (MCLs) must be provided more quickly than public notification for failure to monitor. Contact the Drinking Water Branch for public notification instructions regarding specific violation types.

***How Must Public Notification Be Given?***

The manner in which public notification must be given depends both on the type of violation and on the type of system. Methods of public notification include: 1) notification via electronic media (TV and radio), 2) mail delivery of notification, 3) hand delivery of notification, 4) publishing notification in the newspaper, and 5) posting of public notification. Contact the Drinking Water Branch for public notification instructions regarding specific violation types and system types.

***How Does IDEM Know Whether Public Notification Has Been Done?***

Whenever you carry out public notification, make sure that a copy of the public notification or other evidence that the notification has been carried out (e.g. publisher's affidavit) is forwarded to the Drinking Water Branch. The Drinking Water Branch must be able to confirm that public notification was conducted in order for your system to be considered in compliance with the public notification requirement.

***Who Do I Contact If I Have Questions?***

You should contact the *IDEM Drinking Water Branch* if you have any questions. Remember that public notification requirements will vary depending on violation type and system type. The Drinking Water Branch can provide example public notifications and specific public notification instructions. Our number is (317)308-3282. You may also contact the *IDEM Environmental Helpline* at (800)451-6027, or the *EPA Safe Drinking Water Hotline* at (800)426-4791.

***Rule Citations***

327 IAC 8-2-15, 327 IAC 8-2-16, 327 IAC 8-2-17 and 327 IAC 8-2-18.

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# Nitrate Monitoring Fact Sheet

## ***Who Monitors For Nitrate?***

All Public Water Systems Supplied By Surface Water or Ground Water

All public water systems supplied by ground water or surface water must monitor for nitrate. Nitrate is monitored on either an annual or quarterly basis. The majority of Indiana's public water systems monitor for nitrate annually. However, a significant number are required to conduct quarterly monitoring for nitrate. The required monitoring frequency depends on the system's classification (community, nontransient noncommunity, or transient noncommunity), water source (ground or surface), and the levels of nitrate which have been previously detected in the system's water.

## ***What Are The Health Effects of Nitrate?***

Methemoglobinemia - "blue baby syndrome"

Excessive levels of nitrate in drinking water have caused serious illness and sometimes death in infants under six months of age. The illness caused by high nitrate levels is known as methemoglobinemia or "blue baby syndrome". It is caused when nitrate is converted to nitrite in the body. Nitrite interferes with the oxygen carrying capacity of the infant's blood leading to an acute illness. Symptoms of the illness include shortness of breath and blueness of the skin. Immediate medical attention is needed if these symptoms develop. The maximum contaminant level (MCL) for nitrate has been established at 10 milligrams per liter (mg/l)

## ***What Are Sources of Nitrate?***

Nitrate can enter drinking water from a variety of sources. Potential sources of nitrate include runoff/seepage from fertilized agricultural lands, municipal/industrial wastewater, refuse dumps, animal feedlots, septic tanks, and decaying plant debris. Wells closer to sources of nitrate and shallow wells are more likely to experience nitrate contamination.

## ***Monitoring Frequency for Nitrate***

### **Community and Nontransient Noncommunity Public Water Systems**

#### *Ground Water Systems:*

Base nitrate monitoring for community and nontransient noncommunity public water systems using ground water is required annually. If any result is greater than or equal to 5 mg/l (50% of the MCL for nitrate), the system must conduct quarterly monitoring. Quarterly monitoring must be continued for at least four consecutive quarters. If results are determined to be "reliably and consistently below" the nitrate MCL (10 mg/l), the system may be returned to annual monitoring. Future annual samples must then be taken in the quarter which previously yielded the highest result.

#### *Surface Water Systems:*

Base monitoring for community and nontransient noncommunity public water

systems using surface water is required quarterly. The nitrate monitoring frequency for surface water systems may be reduced to annual if four consecutive quarterly monitoring results for the system are below 5 mg/l. Future annual samples must be taken in the quarter which previously yielded the highest result.

### **Transient Noncommunity Public Water Systems**

Base monitoring for transient noncommunity public water systems (supplied by either ground or surface water) is required annually. If the average of any annual sample result and a confirmation sample is greater than 20 mg/l, the system is required to conduct quarterly monitoring for nitrate (see MCL exceedance discussion below).

### ***What If Nitrate Results Are Greater Than The MCL?***

For all systems, if any annual or quarterly nitrate monitoring result is in excess of 10 mg/l, the system is required to collect a nitrate confirmation sample. The average of the initial and confirmation sample is used to determine compliance with the MCL. Further requirements for specific types of systems are as follows:

### **Community and Nontransient Noncommunity Systems**

If the average of the initial and confirmation samples is greater than 10 mg/l, the system must conduct quarterly nitrate monitoring, issue public notification, and pursue remediation of the contamination.

### **Transient Noncommunity Systems**

If the average of the initial and confirmation sample is between 10 and 20 mg/l, the system may remain on annual monitoring. The system may also continue to supply drinking water subject to the following five conditions: 1) water will not be available to children under six months of age, 2) there will be continuous posting of the fact that nitrate levels exceed 10 mg/l and potential health effects of exposure, 3) local and state public health authorities shall be notified annually of nitrate levels that exceed 10 mg/l, 4) no adverse health effects shall result, and 5) the Commissioner of IDEM may require additional notice to the public. If the average of the initial and confirmation sample is greater than 20 mg/l, the system must provide public notification, conduct quarterly monitoring, and pursue remediation of the contamination.

### ***Who Do I Contact If I Have Questions?***

You should contact the *IDEM Drinking Water Branch* if you have any questions regarding nitrate monitoring. Our number is (317)308-3282. You may also contact the *IDEM Environmental Helpline* at (800)451-6027, or the *EPA Safe Drinking Water Hotline* at (800)426-4791.

### ***Rule Citations***

327 IAC 8-2-4 and 327 IAC 8-2-15

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**Appendix G 1-8****Student self-graded examination answers****Lesson one**

Appendix G-1

<u>Question</u>	<u>Answer</u>
1	C
2	D
3	C
4	A
5	B
6	B
7	B
8	A
9	A
10	B

**Lesson two**

Appendix G-2

<u>Question</u>	<u>Answer</u>
1	A
2	A
3	A
4	D
5	D
6	A
7	C
8	A
9	B
10	A

**Lesson three**

Appendix G-3

<u>Question</u>	<u>Answer</u>
1	B
2	B
3	B
4	A
5	D
6	B
7	A
8	A
9	B
10	D

**Lesson four**

Appendix G-4

<u>Question</u>	<u>Answer</u>
1	B
2	C
3	A
4	B
5	B
6	D
7	B
8	A
9	D
10	A

**Lesson five**

Appendix G-5

<u>Question</u>	<u>Answer</u>
1	A
2	A
3	D
4	C
5	A
6	C
7	B
8	D
9	B
10	B

**Lesson six**

Appendix G-6

<u>Question</u>	<u>Answer</u>
1	A
2	D
3	C
4	A
5	B
6	B
7	B
8	D
9	D
10	C

**Lesson seven**

Appendix G-7

<u>Question</u>	<u>Answer</u>
1	D
2	D
3	B
4	B
5	D
6	B
7	A
8	A
9	B
10	A

**Lesson eight**

Appendix G-8

<u>Question</u>	<u>Answer</u>
1	D
2	A
3	B
4	B
5	B
6	D
7	D
8	C
9	C
10	A

## Appendix H

### Glossary of Terms and Acronyms (Courtesy: Indiana Drinking Water Guidance Manual)

**Action Level** - The level of a contaminant which, if exceeded, requires treatment or other action that a water system must follow

**Acute Contaminant** – A harmful substance that has a rapid effect on humans and/or animals.

**Aesthetic Qualities** – The taste, odor and appearance of drinking water.

**Agreed Order (AO)** - Specifies steps a violator must take to comply with the law. Such steps may include fines for past violations or penalties for failure to complete future compliance steps.

**Air Gap** – The unobstructed vertical distance between the discharge end of a pipeline supplied from a public water supply and the overflow rim of the receiving portion of the customer's water system.

**Alkalinity** - The capacity of water to neutralize acids; that is, the measure of how much acid can be added to a liquid without causing a significant change in pH.



Anthracite -- A dense, shiny coal that has high carbon content and little volatile matter and is often used on top of sand water treatment filters for iron removal.

Aquifer -- The saturated underground formation that will yield usable amounts of water to a well or spring. The formation could be sand, gravel, limestone or sandstone. The water in an aquifer is called groundwater.

- Confined aquifer is the saturated formation between low permeability layers that restrict movement of water vertically into or out of the saturated formation. Water is confined under pressure similar to water in a pipeline. In some areas confined aquifers produce water without pumps (flowing artesian well).
- Unconfined aquifer (water table aquifer) is the saturated formation in which the upper surface fluctuates with addition or subtraction of water. The upper surface of an unconfined aquifer is called the water table. Water, contained in an unconfined aquifer, is free to move laterally in response to differences in the water table elevations.

Arsenic – A poisonous metallic element that comes from erosion of natural deposits, found primarily in rocks, soil, water, and plants. Also comes from runoff of glass and electronics production wastes. Arsenic exposure has been linked to skin damage, circulatory system problems, and an increased risk of cancer.

Arsenic Rule – U.S. Environmental Protection Agency has issued a rule that applies to all community water systems and non-transient, non-community water systems, which sets the maximum contaminant level of arsenic at 10 milligrams per liter.

As-built maps – Maps or drawings depicting the actual installation of pipes and equipment. Also called record drawings. As-builts often differ from original plans.

Asbestos – Inorganic contaminant from old insulation, the decay of asbestos cement in water mains and the erosion of natural deposits.

Potential health effects include increased risk of lung tumors and intestinal polyps.

Backfill -- To refill an excavated area with removed earth; or the material itself that is used to refill an excavated area.

Backflow – The flow of water or contaminants into the public water supply distribution system from a source other than the public water supply. Two acts are necessary for backflow to occur. (1) There must be a link between potable water and another source. This physical arrangement is called a cross connection; and (2) There must also be a pressure difference between the two sources. As water follows the path of least resistance, it will always flow from a higher to a lower pressure. Therefore, a decrease in system pressure or an increase in pressure from the customer side could cause backflow.

Backflow prevention – The best defense for backflow is a proactive backflow prevention program requiring backflow preventers in areas where backflow can occur.

Backflow prevention device – Installed at the water meter, will reduce water pressure and will change the hydraulics of the customer's water system.

Backwash -- The up flow or counter-current flow of water through a filter or ion-exchange medium, lifting the mineral bed and flushing away to the drain the particles of foreign matter that have been filtered from the water supply during the filter cycle.

Bacteria – Single-cell microorganisms that typically reproduce by cell division. Although usually classed as plants, bacteria contain no chlorophyll. Many different types of bacterial organisms are often found in drinking water. Most municipally treated water is generally free of bacteria due to the addition of chlorine. Some forms of cyst type viruses have a degree of immunity to chlorine due to the cocoon-like shell around the virus. These types of organisms such as Cryptosporidium, Giardia Cyst and Giardia Lamblia, and have a physical size of three to seven microns and can be effectively removed by sub-micron filtration. Some bacteria are helpful to humans, others harmful.

Beta particles and photon emitters – A radionuclide from the decay of natural and manmade deposits. Can cause an increased risk of cancer.

Biological activity reactions tests (BART) – Gives an indication or biological fouling, including iron bacteria, slime forming bacteria, and sulfate reducing bacteria.

Boil order (Advisory) – A directive issued to water system users to boil their water because of known or suspected bacteriological contamination.

Booster pump – A pump installed on a pipeline to increase water pressure or flow.

Bromate – A byproduct of drinking water disinfection. Can cause an increased risk of cancer.

Capacity development – The process of determining the managerial, financial and technical capacities of a water system.

Chain of Custody – A written record that shows who handled a sample over what periods of time from the beginning to the end of the sampling and testing process.

Check valve – The check valve in a backflow preventor will close the system.

Chloramines (as  $\text{Cl}_2$ ) – Comes from a water additive used to control microbes. Can potentially cause eye/nose irritation, stomach discomfort, and anemia.

Chlorine (as  $\text{Cl}_2$ ) – Comes from a water additive used to control microbes. Can potentially cause eye/nose irritation and stomach discomfort.

Chlorine dioxide (as  $\text{ClO}_2$ ) – Comes from a water additive used to control microbes. Can potentially cause anemia and affect the nervous system of infants and young children.

Chlorine residual – Lingering chlorine in the water distribution system to kill any other bacteria that might enter the distribution system later.

Clearwells – Water storage structures usually located at the end of a treatment train or well system. Typically used for contact time when chemical treatment additives are used.

CO – Commissioner's Order – If a public water system in violation cannot settle on an Agreed Order, then IDEM will issue a CO. This requires specific action to correct a violation or pay a fine.

Coagulant -- A material such as alum that will form a gelatinous precipitate in water, and gather finely divided particles into larger ones, which can then be removed by settling and/or filtration.

Coliform -- Coliforms are naturally present in the environment. Fecal Coliforms and *E. coli* come from human and animal fecal waste. Total Coliform are used as an indicator that other potential harmful bacteria may be present.

Commissioner's Order (CO) – If a public water system in violation cannot settle on an Agreed Order, then IDEM will issue a CO. This requires specific action to correct a violation or pay a fine.

Community Water System (CWS) – A public water system that serves the same 25 or more people year-round.

Compound meters – These meters are used where there is a need to measure both high and low flows, like in a hotel, school, or a commercial account where both domestic use and production use need to be measured by one meter. They are typically available in sizes from 2” through 6”.

Condensation -- the process of water vapor in the air turning into liquid water.

Cone of depression -- A depression in groundwater levels around a well in response to groundwater withdrawal or pumping water.

Consumer Confidence Report (CCR) – All community water systems are required to deliver to their customers an annual report. This report must contain information on the quality of the water delivered by the system and characterize the risks, if any, from exposure to contaminants detected in the drinking water in an accurate and understandable manner. Systems shall deliver their reports no later than July 1 annually. Each report must contain data collected during, or prior to, the previous calendar year. A community water system that sells water to another community water system shall deliver the applicable information noted above to the buyer system no later than April 1 annually.

Contaminants – Adversely affect public health and occur in drinking water with a frequency and at levels that pose a threat to public health. U.S. EPA has set standards for 90 contaminants, seven of which are new standards that became enforceable on January 1, 2002.

Copper – Inorganic contaminant from corrosion of household plumbing systems and erosion of natural deposits. Copper is an essential nutrient in low concentrations. Potential health effects in the short term include stomach and intestinal distress. Potential health effects of long-term exposure include liver and kidney damage, and anemia. Persons with Wilson’s Disease should consult their personal doctor if their water system exceeds the copper action level.

Cross connection – The link between potable water and another source. This physical arrangement is called a cross connection. Any physical arrangement, including cross connection control devices not in working order, whereby a public water supply distribution system is directly connected, either continuously or intermittently, with any secondary source of supply, sewer, drain, conduit, pool, piping, storage reservoir, plumbing fixture, or other device which contains, or may contain, and is capable of imparting to the public water supply, contaminants, contaminated water, sewage, or other waste or liquid of unknown or unsafe quality.

Cross connection control device – Any device or assembly, approved by the Commissioner for construction on or installation in water supply piping, which is capable of preventing contaminants from entering the public water supply distribution system.

Cross connection control device inspector – A person who has: (1) Successfully completed training in testing and inspection of cross connection control devices from a training provider approved by the Commissioner; (2) Received a registration number from the Commissioner; and (3) Not been notified by the Commissioner that the registration number has been revoked.

Cross connection hazard – Any customer facility which, because of the nature and extent of activities on the premises, or the materials used in connection with the activities or stored on the premises, would present an immediate or potential danger or health hazard to customers of the public water supply should backflow occur.

Cryptosporidium – A microorganism found in human and animal fecal waste. Can cause gastrointestinal illness (e.g. diarrhea, vomiting, cramps).

Customer service line – The pipeline from the public water supply to the: (1) First tap, fixture, receptacle, or other point of customer water use; or (2) Secondary source of supply or pipeline branch in a building.

Customer water system – All piping, fixtures, and appurtenances, including secondary sources of supply, used by a customer to convey water on his premises.

DBPR -- Disinfectants/Disinfection By-Products Rule – The purpose of this rule is to reduce public exposure to three chemical disinfectants (chlorine, chloramines, and chlorine dioxide) and many disinfection by-products (total trihalomethanes, haloacetic acids, chlorite, and bromate).

Disinfectant residual – Lingering disinfectant in the water distribution system to kill any other bacteria that might enter the distribution system later.

Displacement meters – These are used for measurement of low and intermediate flows, like domestic use applications. They are typically available in sizes from 5/8” through 2”.

Double check valve assembly – A type of backflow prevention device. This device or assembly is composed of two tightly closing shut-off valves surrounding two independently acting check valves, with four test cocks, one upstream of the four valves, and one between each of the four check and shut-off valves.

Downstream – The direction of flow when only the public water supply is supplying water through the customer water system and backflow is not occurring.

Drainage basin – Area of land surface, which slopes down and receives water from rivulets, books, creeks, and streams.

Drawdown -- The lowering of the groundwater surface caused by withdrawal or pumping of water from a well. It is the difference between the static water level and the pumping water level in a well pumped at a constant flow rate.

Drinking Water Branch (Indiana Department of Environmental Management) – There are four (4) sections within the Drinking Water Branch, which perform functions related to monitoring and compliance with regulations, and technical assistance to public water systems.

Drinking Water Standards – Drinking water standards apply to all public water systems, which provide water to at least 15 connections or 25 persons at least 60 days out of the year.

*E. Coli* -- *E. coli* microorganisms come from human and animal fecal waste. Can cause gastrointestinal illness (e.g., diarrhea, vomiting, cramps).

Emergency Orders –IDEM enforcement tool which calls for immediate action to stop activities that threaten human or environmental health. This is a temporary order that expires 90 days from its issuance.

EPA – U.S. Environmental Protection Agency

Evaporation – The conversion of water from a liquid into a gas.

Feasible – As defined in the Safe Drinking Water Act – The level that may be achieved with the use of the best technology, treatment techniques, and other means which U.S. EPA finds (after examination for efficiency under field conditions) are viable, taking cost into consideration.

Fecal coliform -- Fecal coliform microorganisms come from human and animal fecal waste. Can cause gastrointestinal illness (e.g. diarrhea, vomiting, cramps).

FIFRA -- Federal Insecticide, Fungicide, and Rodenticide Act

Filter Backwash Recycle Rule (FBRR) – The purpose of this rule is to require system to review their recycle practices and, where appropriate, work with the State to make any necessary changes to recycle practices that may compromise microbial control. This FBRR applies to all public water systems that (1) use surface or ground water under the direct influence of surface water; (2) utilize direct or conventional filtration processes; and (3) recycle spent filter backwash water, sludge thickener supernatant, or liquids from dewatering processes.

Filter profile – Graphical representation of an individual filter performance.

Fire service meter – These meters are used to measure water from fire lines. There are several types of fire line meters. Some measure all of the water going through the fire line in the event of a fire – these are typically large turbo meters. Some only measure a portion of the water going through the fire line -- this is called proportional metering. Some only measure low flows of water used when there isn't a fire – these are called detector meters. There are also fire meters available that can measure both low flow domestic use and high flow fire fighting use. These are really large, parallel type compounds. They consist of a large turbo meter, a change over valve, and a 1-1/2" or 2" displacement or turbo meter to measure the domestic use.

Fixed-radius Wellhead Protection Plan – A 3,000 foot radius Wellhead Protection Area delineation that may be used by qualifying water systems that pump less than 100,000 gallons of water per day.

Fluoride – Inorganic contaminant which comes from a water additive that is used to promote strong teeth, erosion of natural deposits, and discharge from fertilizer and aluminum factories. Can cause dental fluorosis (staining) and skeletal fluorosis (bone damage).

Flush – To run large quantities of water through an item (e.g., water main).

GAC – granular activated carbon – Media often placed on top of filter to help remove taste and odor from the water.

*Giardia lamblia* – A microorganism found in human and animal fecal waste. Can cause gastrointestinal illness (e.g., diarrhea, vomiting, cramps).

Ground Water Rule (GWR) – U.S. Environmental Protection Agency rule to protect public health from waterborne microorganisms present in ground water sources (i.e., sources unaffected by surface water). The GWR specifies the appropriate use of disinfection in ground water and establishes a strategy to identify ground water systems at high risk for contamination.

GWUDI – Ground Water Under the Direct Influence (of Surface Water)

HazMat Team – Hazardous Materials Team

Heterotrophic Plate Count (HPC) – Measures a range of bacteria that are naturally present in the environment. HPC has no health effects, but can indicate how effective treatment is at controlling microorganisms.

Hydrant diffuser – Dissipates the force of flowing water.

Hydrogeologic barrier – Consists of physical, chemical, and biological factors that, singularly or in combination, prevent the movement of viable pathogens from a contaminant source to a public water supply well.

Hydrologic cycle describes the constant movement of water above, on, and below the earth's surface. Processes such as precipitation, evaporation, condensation, infiltration, runoff and transpiration comprise the cycle. Within the cycle, water changes form in response to the Earth's climatic conditions.

Hydrogeologic Sensitivity Assessment – Is designed to identify wells that may be sensitive to fecal contamination. Sensitive hydrogeologic settings are aquifers that allow ground water to travel at high velocities.

IAC – Indiana Administrative Code – Indiana regulations.

IC – Indiana Code – Indiana statutes (laws).

IDEM – Indiana Department of Environmental Management --

IDEM, DWB – Indiana Department of Environmental Management, Drinking Water Branch

IDEM OE -- Indiana Department of Environmental Management, Office of Enforcement – Office with regulatory enforcement over Indiana’s public water systems. Aims to help ensure that safe drinking water is provided by responding to violations with timely, quality enforcement actions that accomplish three goals: Achieve compliance, Deter future violations, and Result in an improved environment.

IDEM OWQ -- Indiana Department of Environmental Management, Office of Water Quality – Once a water quality violation is noted, this department evaluates the nature of the violation. If the violation is not serious, this department works with the violator to correct the problem. If the violation is deemed to be serious in nature or remains uncorrected, it is referred to the Office of Enforcement.

IDSE – Initial distribution system evaluation. Sampling process used to determine DBP sampling sites under stage 2 DPB Rule.

Judicial Order – IDEM enforcement tool which is issued by a court of record, such as a Superior Court or Circuit Court.

Lead – An inorganic contaminant from corrosion of household plumbing systems and erosion of natural deposits. Lead interferes with blood cell chemistry; can cause abnormal physical and mental development in infants and young children; slight deficits in the attention span, hearing, and learning abilities of children. Lead is also linked to high blood pressure and kidney problems in adults.

Legionella – A microorganism found naturally in water that multiplies in heating systems. Can potentially cause Legionnaire’s Disease.

Long Term 1 Enhanced Surface Water Treatment Rule (LT1-ESWTR) – The purpose of this rule is to improve small systems' control of microbial pathogens in drinking water, particularly for the protozoan *Cryptosporidium*. In addition, the rule includes provisions to assure continued levels of microbial protection while utilities take the necessary steps to comply with new disinfection by-product standards. This rule became final in July, 2001. Systems serving 500 to 9,999 people must comply with disinfection profiling requirements by January 2003. Those serving 25 to 499 people must comply by July 2003. Transient, noncommunity systems are exempt from disinfection profiling.

Long Term 2 Enhanced Surface Water Treatment Rule (LT2-ESWTR) – The purpose of this rule is to (1) improve control of microbial pathogens, particularly *Cryptosporidium*, and (2) address risk trade-offs with disinfection by-products.

Maximum Contaminant Level (MCL) – The highest level of a contaminant that is allowed in drinking water. Maximum contaminant levels are set as close to maximum contaminant level goals as feasible, using the best available treatment technology and taking cost into consideration. Maximum contaminant levels are enforceable standards.

Maximum Contaminant Level Goal (MCLG) – The level of a contaminant in drinking water below which there is no known or expected risk to health. Maximum contaminant level goals allow for a margin of safety and are non-enforceable public health goals.

Maximum Residual Disinfection Level (MRDL) – The highest level of a disinfectant allowed in drinking water. There is convincing evidence that the addition of a disinfectant is necessary for control of microbial contaminants.

Maximum Residual Disinfectant Level Goal (MRDLG) – The level of a drinking water disinfectant below which there is no known or expected risk to health. Maximum Residual Disinfectant Level Goals do not reflect the benefits of the use of disinfectants to control microbial contaminants.

Meter maintenance program – Scheduled program whereby meters are tested and repaired before there is a noticeable drop in consumption.

Mg/l – milligrams per liter – Equivalent to parts per million.

MRO – Monthly Report of Operations of water systems.

MSDS – Material Safety Data Sheets.

Multi-jet meters – These are used for measurement of low and intermediate flows, like domestic use applications. They are typically available in sizes from 5/8” through 2”.

Municipally-owned water system – A municipally owned water system is a public water system that is owned and operated by a local government or urban political unit with corporate status. Normally the mayor or water board is the policy making body.

National Primary Drinking Water Regulations (NPDWR or primary standards) – These are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water.

National Secondary Drinking Water Regulations (NSDWR or secondary standards) – These are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. U.S. EPA recommends secondary standards to water systems, but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

Nephelometric Turbidity Unit (NTU) – A measurement of turbidity.

Nitrate (measured as nitrogen) – Inorganic contaminant from runoff from fertilizer use, leaching from septic tanks and sewage systems, and erosion of natural deposits. Converts to Nitrite that can cause Methemoglobinemia.

Nitrite (measured as nitrogen) – Inorganic contaminant from runoff from fertilizer use, leaching from septic tanks and sewage systems, and erosion of natural deposits. Can cause Methemoglobinemia (“blue baby syndrome”) in infants less than 6 months in age. This is life threatening without immediate medical attention. Symptoms: infant looks blue and has shortness of breath.

Noncommunity Water System (NCWS) – A public water system that serves the public, but does not serve the same people year-round. There are two types of noncommunity systems: Nontransient Noncommunity Water Systems and Transient Noncommunity Water Systems.

Nontransient Noncommunity Water System (NTNCWS) – A public water system that serves the same 25 or more people more than six months per year, but not year-round. For example, a school with its own water supply is considered a nontransient noncommunity system.

Notice of Violation (NOV) – Issued to a public water system in violation. Invites the system to attend a settlement conference to discuss solutions. After receiving the Notice of Violation, the violator has a 60-day settlement period to enter into an Agreed Order with IDEM.

NPDWR -- National Primary Drinking Water Regulations (or primary standards) – These are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water.

NSDWR -- National Secondary Drinking Water Regulations (or secondary standards) – These are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. U.S. EPA recommends secondary standards to water systems, but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

O & M – operations and maintenance.

Office of Enforcement (OE) – If initial investigation does not resolve a violation, then IDEM’s Office of Enforcement issues a Notice of Violation (NOV) to the public water system inviting them to attend a settlement conference to discuss solutions.

Office of Environmental Adjudication – If a violator appeals an IDEM Commissioner’s Order, then this department reviews the case prior to a hearing.

Operator Certification – U.S. EPA finalized minimum national guidance for operator certification in February 1999, with additional requirements proposed in July 2000. Prior to the development of national guidelines, certification of drinking water system operators had been required only at the state level, with standards varying widely from state to state and many programs exempting small water systems. The recent national standards apply to all community water systems and nontransient, noncommunity water systems, regardless of system size.

Outlet structure – Controls the release of stored water.

Pathogen -- An agent that causes disease, especially a living microorganism such as a bacterium.

Pentachlorophenol – Organic contaminant from wood preserving factories discharge. Can cause damage to liver and kidneys, have adverse affects on the reproductive system, and an increased risk of cancer.

Perennial stream – Continuously flowing streams that are supplied both by surface runoff and springs, and by ground water seepage.

pH -- A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale usually ranges from 0 to 14

Photon emitters and beta particles – A radionuclide from the decay of natural and manmade deposits. Can cause an increased risk of cancer.

Picloram – Organic contaminant from herbicide runoff. Can cause damage to liver and kidneys.

Pitot Gauge – Measures pressure of flowing water.

Polychlorinated biphenyls (PCBs) – Organic contaminant from landfill runoff and discharge of waste chemicals. Can cause skin changes, thymus gland problems, immune deficiencies, reproductive difficulties, nervous system problems, and an increased risk of cancer.

Part-per-million (ppm) is a measure of concentration of a dissolved material in terms of a mass ratio (milligrams per kilogram, mg/kg). One part of a contaminant is present for each million parts of water. For water analysis, parts per million often is presented as a mass per unit volume (milligrams per liter, mg/l). There are one million milligrams of water in one liter.

Pressure vacuum breaker – A type of backflow prevention device. A device or assembly containing an independently operating internal loaded check valve and an independently operating loaded air inlet valve located on the downstream side of the check valve for relieving a vacuum or partial vacuum in a pipeline.

Primacy – Primary enforcement authority granted by U.S. EPA to states that meet certain requirements, including setting regulations that are at least as stringent as U.S. EPA's. Indiana has been granted primacy.

Privately-owned water system – A privately-owned water system is a public water system owned by one or more private investors (individuals, partnerships, corporations, or other qualified entity), with the equity provided by investors or shareholders.

Production meter – Meters on wells for water leaving the plant or pumping station.

Propeller meter – These meters are used to measure water from wells and water plants. They are used where there are no low or intermediate flows where the pumps are either on or off. They are typically available in sizes from 2” through 72”.

Protozoan -- Any of a large group of single-celled, usually microscopic, eukaryotic organisms, such as amoebas, ciliates, flagellates, and sporozoans.

Public Notification – The process used by water systems to notify their customers, guests, and employees when the water system has violated a drinking water regulation.

Public Water System (PWS) – A public water supply for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals daily at least sixty days out of the year. The term includes any collection, treatment, storage, and distribution facilities under control of the operator of such system, and used primarily in connection with such system and any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system.

Public Water System Identification (PWSID) Number – The unique number issued by the Indiana Department of Environmental Management to identify public water supplies.

Radon – Radon is a colorless, odorless, tasteless, chemically inert, and radioactive gas. It forms naturally from the radioactive decay of uranium and is most commonly found in soils and ground waters. The primary risk of exposure is lung cancer from radon entering indoor air from soil under homes. Tap water is a smaller source of radon in air. Breathing radon released to air from household water uses also increases the risk of lung cancer, and consumption of drinking water containing radon presents a smaller risk of internal organ cancers, primarily stomach cancer.

Radon Rule – The Radon Rule was developed to reduce public radon exposure and applies to all community water systems that use ground water or mixed ground and surface water. The regulation does not apply to nontransient noncommunity public water supplies or to transient public water supplies. The Radon Rule was proposed in November 1999 and is expected to become final in 2004.

Rate – Monies collected for water provided – Every water utility must receive sufficient total revenue to ensure proper operations and maintenance, development and perpetuation of the system, and the preservation of the utility's financial integrity.

Rate structure – Means of establishing charges for water usage. Different types of rates that could be used are: Lifeline Rates and Low Income Discounts, Inverted Block Rate, Declining Block Rate, Uniform Volume Rate, Economic Development Rate, Off-Peak Rate, Seasonal Rate, Negotiated Contractual Rate, Marginal-Cost Pricing Rate, Indexing or Indexed Rate, Rate Schedule by Customer Class.

Reduced pressure principle backflow preventer – A device composed of two tightly closing shut-off valves surrounding two independently acting pressure reducing check valves that, in turn, surround an automatic pressure differential relief valve, and four test cocks, one upstream of the five valves and one between each of the four check and shut-off valves. The check valves effectively divide the structure into three chambers; pressure is reduced in each downstream chamber allowing the pressure differential relief valve to vent the center chamber to atmosphere should either or both check valves malfunction.

Reservoir – A basin designed to store water during periods in which the stream flow is greater than the demand and to deliver water during periods when the reverse condition occurs.

Retail water meter – Meters to monitor large customer water usage.

Riparian Water Right -- The legal right held by an owner of land contiguous to or bordering on a natural stream or lake, to take water from the source for use on the contiguous land.

Rural Utilities Service of the United States Department of Agriculture (USDA) Program – Federal funds program available to states for water system infrastructure improvements for regulatory compliance.

Safe Drinking Water Act – This law established national drinking water standards that were to be administered and enforced by State agencies. The SDWA was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources. The 1996 amendments greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public right-to-know as important components of safe drinking water. The SDWA applies to every public water system in the United States.

Sanitary Survey – On-site IDEM review to inspect the water source, facilities, equipment, wellhead protection information, operation, maintenance, monitoring compliance and other important aspects of a public water system.

Secondary source of supply – Any well, spring, cistern, lake, stream, or other water source, intake structure, pumps, piping, treatment units, tanks, and appurtenances used, either continually or intermittently, to supply water other than from the public water supply to the customer, including tanks used to store water to be used only for firefighting, even though the water contained therein is supplied from the public water supply.

Shock chlorination -- The addition of chlorine for disinfecting a water supply system including the well, and all distribution pipelines. Shock chlorination is recommended when coliform bacteria are detected, or after system repairs. Treated water, with a concentration of at least 200 ppm, is pumped throughout the distribution system and allowed to set for at least 24 hours before flushing with untreated water.

Shoring equipment – Equipment installed in trenches to prevent the collapse of the trench.

Significant Water Withdrawal Facility – Any groundwater supply with a withdrawal capacity of more than 100,000 gallons per day. This supply must be registered with the Indiana Department of Natural Resources.

Specific capacity -- Expresses the productivity of a well. Specific capacity is obtained by dividing the well discharge rate by the well drawdown while pumping. It is calculated by dividing the production of the well in gallons per minute by the feet of drawdown between the static water level and the pumping water level. Water levels need to stabilize before measurements are made. The gallons per minute should be the normal production rate of the well and pumping equipment.

Stage 1 - Disinfectants/Disinfection By-Products Rule (Stage 1 DBPR) -- The purpose of this rule is to reduce public exposure to three chemical disinfectants (chlorine, chloramines, and chlorine dioxide) and many disinfection by-products (total trihalomethanes, haloacetic acids, chlorite, and bromate).

Stage 2 - Disinfectants/Disinfection By-Products Rule (Stage 2 DBPR) -- The rule builds upon the Stage 1 DBPR to further reduce public exposure to disinfection by-products. Because disinfection by-product concentrations can increase with increase time (i.e., increasing water age), the U.S. EPA is emphasizing compliance monitoring locations that reflect parts of the distribution system with older water. Compliance monitoring for the Stage 2 DBPR will be preceded by an initial distribution system evaluation to select site-specific optimal sample points for capturing peaks. The requirements for Stage 2 DBPR will apply to all community water systems and nontransient noncommunity water systems that add a disinfectant other than UV or deliver water that has been disinfected. This proposed rule is anticipated to be published in 2004. Compliance dates are anticipated between 2008 and 2010.

Static water level is the water level in a well located in an unconfined aquifer when the pump is not operating. The static water level is the surface of the water-bearing formation and typically is synonymous with the water table.

Supplemental Environmental Projects (SEPs) – Environmental improvement projects that violators can perform to further offset penalties.

Supplier of water – Any person who owns or operates a public water supply.

Toluene – Organic contaminant from petroleum factories discharge. Can cause damage to kidneys, liver, nervous system, and circulatory system.

Total Coliform (including fecal coliform and *E. coli*) – Coliforms are naturally present in the environment. Fecal Coliforms and *E. coli* come from human and animal fecal waste. Total Coliform are used as in indicator that other potential harmful bacteria may be present.

Transient Noncommunity Water System (TNCWS) – Serves the public, but not the same individuals for more than six months. For example, a rest area or campground may be considered a transient noncommunity water system.

Transmissivity -- The capacity of an aquifer to transmit water. It is dependent on the water-transmitting characteristics of the saturated formation (hydraulic conductivity) and the saturated thickness. For example, sand and gravel formations typically have greater hydraulic conductivities than sandstone formations. The sand and gravel will have a greater transmissivity if both formations are the same thickness.

Transpiration – The evaporation of water from plants.

Treatment Technique – A required process intended to reduce the level of a contaminant in drinking water.

Trihalomethanes (TTHM) -- A byproduct of drinking water disinfection. Can cause liver, kidney, or central nervous system problems, as well as increase the risk of cancer.

Turbidity – a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness. Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. These microorganisms can come from soil runoff. They can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.

Turbine meters – These meters are used to measure intermediate and high flows like commercial user with high volumes of water, or to measure the water leaving the water plant. They are typically available in sizes from 2” through 20”.

Underground Injection Control (UIC) – Program to control the injection of wastes into ground water.

Unidirectional flushing – A method of water main flushing wherein valves are closed to create artificial dead ends, thereby forcing water to flow from only one direction.

U.S. Environmental Protection Agency (U.S. EPA or USEPA) -- Indiana is part of U.S. EPA Region 5, which also includes Illinois, Michigan, Minnesota, Ohio, and Wisconsin.

Viruses (enteric) – Microorganisms found in human and animal fecal waste. Can cause gastrointestinal illness (e.g., diarrhea, vomiting, cramps).

Water table -- the upper level of a saturated formation where the water is at atmospheric pressure. The water table is the upper surface of an unconfined aquifer.

Wellhead Protection Area (WHPA) – The land surface and subsurface area surrounding a wellfield through which water, or contaminants, can enter the ground and move toward the wellfield within a specified time period.

Wellhead Protection Plan – A written plan to protect wellhead from reasonably foreseeable potential sources of contaminants.

Wilson's Disease – A disease caused by the body's inability to metabolize Copper.