SMALL WATER SYSTEM

OPERATOR CERTIFICATION MANUAL

For Other-Than-Municipal and Nontransient Noncommunity Public Water Systems

Fourth Edition

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EXECUTIVE SUMMARY

The Federal Safe Drinking Water Act and amendments require all community and nontransient noncommunity public water systems to have an appropriately certified operator managing the system. The intent of this certification requirement is to ensure that the operators of these water systems have the necessary knowledge and training to provide a safe and dependable supply of drinking water to their customers.

This manual has been developed for small water system operators to assist in compiling the aforementioned necessary knowledge. The manual is intended to be used as a study guide for the certification exam and as a comprehensive reference manual containing information on all aspects of water system processes and procedures to assist drinking water providers in their day-to-day operations.

Small Water System Operator Certification

Wisconsin's Small Water System Operator Certification program for "Other-Than-Municipal" and "Nontransient Noncommunity" water systems provides training classes and exams throughout the state. The class typically consists of 3-4 hours of training, covering information provided in this manual. The exam consists of approximately 40 multiple choice questions. An operator must correctly answer 75 percent or more of the questions to obtain state certification.

Certification Renewal

Once certified, an operator must also acquire at least 6 hours of continuing education credits every 3 years to maintain certification. These credits are obtained by attending state-approved training classes on subjects relating to the water industry. Information on upcoming approved classes as well as the status of an operator's certification can be found on the DNR website at http://dnr.wi.gov/ by typing "Operator Certification" in the Search box.

The production of this manual was a cooperative effort of staff of the Wisconsin Department of Natural Resources Bureau of Drinking Water and Groundwater and the Wisconsin Rural Water Association, with input from a Peer Review Committee consisting of individuals from all areas of the drinking water industry in Wisconsin.

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1.1- DRINKING WATER REGULATIONS

1.1.1-The History of Drinking Water Regulations

Federal authority to establish drinking water standards was first enacted by Congress in 1893 with the passage of the Interstate Quarantine Act. The primary intent of this act was to prevent the spread of disease both from other countries into the United States and from state to state. The provisions of the Interstate Quarantine Act were enforced by the US Public Health Service (USPHS) and at the time, only applied to water systems that provided water to interstate means of transportation, such as boats and trains.

The USPHS developed more comprehensive standards for drinking water over the years, including some limits on chemical, physical, and bacteriological contamination. These standards were not mandatory, but they were usually adopted by those states that developed their own requirements for public water systems.

Technological advances made in the 1960's and 1970's allowed for better identification and detection of disease-causing organisms and chemicals in water. There was increasing pressure on the federal government to create uniform, nationwide drinking water standards for public water systems. The act that followed was called the ***Safe Drinking Water Act (SDWA)*** and was first passed by Congress in 1974. It has been amended since then, most recently in 1996. The SDWA not only sets water quality standards, but it also contains other regulations for the water industry which are important in protecting public health.

1.1.2- US Environmental Protection Agency

The federal agency responsible for establishing public drinking water standards and enforcing the requirements of the SDWA is the ***U.S. Environmental Protection Agency (EPA)***. However, the EPA can delegate enforcement authority to the states. This is called "***Primacy Authority.***" Most states have primacy authority to enforce the provisions of the SDWA in their state. If they do, they must establish requirements at least as stringent as those set by EPA.

1.1.3- Wisconsin Drinking Water Regulations

Wisconsin has long been recognized as a leader in the protection of natural resources and public health through stringent water regulations. Wisconsin has received approval from EPA to have primacy authority for enforcing public drinking water regulations in the state. These regulations are enforced by the Wisconsin Department of Natural Resources (DNR). In the DNR, the ***Bureau of Drinking Water and Groundwater*** is responsible for enforcing SDWA regulations.

The DNR not only enforces drinking water standards, such as those in the SDWA, but it is also responsible for establishing and enforcing standards and regulations for water system design, construction, operation and maintenance, well construction and placement, pumps, treatment processes, chemical addition, well filling and sealing, lab certification, and wellhead protection. To ensure that water systems meet these state requirements, community water system owners are responsible for obtaining plan approvals from the DNR for well construction, pump installation, well rehabilitation, chemical addition to water, water treatment, and new system capacity. ***Plan Approvals*** help ensure that water suppliers provide a safe and dependable supply of water to their customers. ***Monitoring Assessments*** of water sources are conducted every three years for eligible systems applying for monitoring waivers.

1.2- PUBLIC WATER SYSTEM CLASSIFICATION

SDWA regulations apply to all public water systems. The WI Administrative Code definition of a ***public water system,*** or "PWS", is a system that provides water for human consumption through pipes or other constructed conveyances. If the system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year, it is a public water system. Public water systems may then be broken down into two major classes. These classes are community water systems that serve ***residential*** consumers and noncommunity water systems that serve ***non-residential or transient*** consumers.

The classification of a public water system determines the level of regulation that a system must follow. In general, community water systems and non-transient non-community water systems are subject to stricter requirements than transient non-community water systems. State and federal regulations define "serves or serving" to mean "provides or providing" the opportunity for human consumption. This is not always the same as the number of people who actually drink the water on a daily basis. The "serves or serving" definition is important because even if a supplier provides bottled water for drinking but has plumbing fixtures supplied by a well, the water which comes out of those fixtures must meet drinking water standards.

1.2.1 Community Water Systems

"Community water system" or "CWS" means a public water system serves at least 15 service connections and is used by year−round residents or regularly serves at least 25 year−round residents. Any public water system serving seven or more homes, 10 or more mobile homes, 10 or more apartment units, or 10 or more condominium units is a community water system unless information is available to indicate that 25 year−round residents will not be served. Community water systems are divided into two sub-categories, municipal and other-than-municipal.

A. A ***municipal water system (MC)*** is owned by a municipality such as a city, town, village, sanitary district, or a state, county or federal institution.

B. An ***other than municipal water system (OTM or OC)*** is owned by an entity other than a municipality such as a subdivision, mobile home park, apartment complex or condominium association.

1.2.2- Non-community Water Systems

"Non−community water system" or "NCWS" means a public water system is not a community water system. Non−community water systems are also divided into two sub-categories, non−transient non−community water system or a transient non−community water system.

A. A ***transient non-community water system (TN)*** is a water system that serves at least 25 people at least 60 days of the year, but those served change from day to day. Examples of TN systems include taverns, hotels, restaurants, churches, campgrounds, parks and gas stations.

B. A ***non-transient non-community water system (NN)*** is a water system that regularly serves at least 25 of the same people for six or more months of the year. EPA defines "regularly serves" as being four or more hours per day, four or more days per week for 26 weeks or more per year. Examples of NN systems include schools, day-care centers, factories and businesses.

1.3- LEGAL DEFINITIONS OF WATER SYSTEMS

The following Wisconsin Administrative Code chapters are the primary state codes used to implement the requirements of the SDWA in Wisconsin.

NR 114	Certification Requirements for Waterworks, Wastewater Treatment Plant, Septage Servicing and Water System Operators
NR 809	Safe Drinking Water
NR 810	Requirements for the Operation and Maintenance of Public Water Systems
NR 811	Requirements for the Operation and Design of Community Water Systems
NR 812	Well Construction and Pump Installation

They contain the following definitions:

> **NR 809.04(67)** "Public water system" or "system" or "PWS" means a system for the provision to the public of piped water for human consumption through pipes or other constructed conveyances, if the system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. A public water system is either a "community water system" or a "non–community water system".
>
> A system:
>
> (a) Includes any collection, treatment, storage, and distribution facilities under control of the operator of the system and used primarily in connection with the system.
>
> (b) Includes any collection or pretreatment storage facilities not under the system's control which are used primarily in connection with the system.
>
> (c) Does not include any ''special irrigation district.''
>
> **NR 809.04(5)** "Community water system" or "CWS" means a public water system which serves at least 15 service connections used by year–round residents or regularly serves at least 25 year–round residents. Any public water system serving 7 or more homes, 10 or more mobile homes, 10 or more apartment units, or 10 or more condominium units is a community water system unless information is available to indicate that 25 year–round residents will not be served.
>
> **NR 811.02(41)** "Municipal water system" means a community water system owned by a city, village, county, town, town sanitary district, utility district, public inland lake and rehabilitation district, municipal water district or a federal, state, county or municipal owned institution for congregate care or correction, or a privately-owned water utility serving the foregoing.
>
> **NR 811.02(45)** "Other–than–municipal water system" means a community water system that is not a municipal water system.
>
> **NR 809.04(57)** "Non-community water system" or "NCWS" means a public water system that is not a community water system. A non-community water system is either a non-transient, non-community water system or a transient non-community water system.
>
> **NR 809.04(58)** "Non-transient non-community water system" or "NTNCWS" means a non-community water system that regularly serves at least 25 of the same

persons over 6 months per year. Examples of non-transient non-community water systems include those serving schools, day care centers and factories.

NR 809.04(74m) “Serves or serving” means provides or providing the opportunity for human consumption.

NR 809.04(89) “Transient non-community water system” or "TNCWS" means a non-community water system that serves at least 25 people at least 60 days of the year but does not regularly serve at least 25 of the same persons over 6 months per year. Examples of transient non-community water systems include those serving taverns, motels, restaurants, churches, campgrounds and parks.

1.4- <u>DRINKING WATER STANDARDS</u>

Drinking water standards are divided into two categories. Health related drinking water standards are called ***Primary Drinking Water Standards***, and non-health related aesthetic standards are called ***Secondary Drinking Water Standards***. Public water systems must provide water that meets all applicable standards for their specific system type.

1.4.1- Primary Drinking Water Standards

Primary drinking water standards are those dealing with contaminants that are known to have an adverse effect on human health. EPA has determined a ***Maximum Contaminant Level (MCL)*** for each regulated contaminant that poses a public health risk The maximum contaminant level or MCL is the maximum amount (concentration) of that particular contaminant in drinking water allowed by EPA. The EPA has determined that water containing amounts of a contaminant at or below the MCL do not pose a significant risk to public health.

There are two catagories of drinking water contaminants, microbial and chemical. All public water systems montior for microbial contaminants plus the chemical contaminates nitrate and nitrite. Other chemical MCLs only apply to community (municipal and other-than-municipal) and non-transient non-community water systems, such as the MCLs for volatile organic compounds (VOCs). EPA has established ***Action Levels,*** as opposed to MCLs, for some contaminants such as lead and copper. It is important to remember that as new health effects data become available, a MCL may be adjusted either up or down, depending on what the latest data shows.

1.4.2- Secondary Drinking Water Standards

Secondary drinking water standards deal with contaminants that affect the aesthetic quality of drinking water. These standards apply to such contaminants as iron, manganese, color, odor, and taste. As these contaminants have minimum adverse health effects, public water systems are generally not required by state or federal drinking water regulations to meet these standards. The regulations do however give primacy agencies authority to monitor for and require corrective action when a secondary standard is exceeded and the resulting water quality is "*objectionable to an appreciable number of persons*" or "*detrimental to the public welfare* ."

1.4.3- Maximum Contaminant Level Goal

Before setting a maximum contaminant level (MCL) for any health related drinking water contaminant, the Safe Drinking Water Act requires EPA to set what is called a ***Maximum Contaminant Level Goal (MCLG)***. The MCLG for a contaminant is the level at which there is no known or anticipated adverse health effect to humans. This level is expected to provide complete protection of public health, thus in many cases the MCLG is set at zero. It is often significantly lower than the MCL because the MCLG does not take into account cost, treatability, or detectability of a contaminant.

1.4.4- Best Available Technology

Realizing that, in some cases, it is not technologically or financially feasible to achieve the MCLG for all contaminants, EPA establishes MCLs for all regulated contaminants in drinking water. In doing so, they take into account such factors as health risk assessments, cost-benefit analysis, and ***Best Available Technology (BAT)*** in establishing acceptable levels. The BAT refers to the technology available to detect and treat the contaminant of concern.

1.4.5- Treatment Technique Requirement

For some contaminants, establishing a specific MCL is either not possible or too costly to mandate. For such contaminants, EPA may require specific water treatment practices called ***Treatment Technique Requirements (TTR),*** which when implemented by the water system, would reasonably protect public health. Examples of TTR are corrosion control for reduction of lead and copper and filtration for removal of particulates in surface water.

1.5- OPERATOR REQUIREMENTS

All community and non-transient non-community water systems must have a certified operator in charge (OIC). Following are the four requirements to be a water system operator:

> **(1)** The person shall possess a high school diploma or a general equivalency diploma -OR- the person shall have a minimum of 2 years' experience operating a water system prior to December 1, 2000.
>
> **(2)** A person shall submit a completed application and successfully pass the examination.
>
> **(3)** The operator−in−charge of a water system shall be available during each operating shift.
>
> **(4)** To continue certification under this subchapter, each certified water system operator shall renew his or her certificate every 3 years.

Once certified, an operator must also acquire at least 6 hours of continuing education credits every 3 years to maintain certification. These credits are obtained by attending state approved training classes on subjects relating to the water industry. Information on upcoming approved classes as well as the status of an operator's certification can be found on the DNR website at http://dnr.wi.gov/ by typing "Operator Certification" in the Search box. The Operator Certification Program helps to ensure that water systems are run by appropriately trained and certified operators.

1.6- SANITARY SURVEYS

DNR personnel assure compliance with all appropriate codes and regulations by performing periodic on-site inspections of all public water systems. These inspections are called ***sanitary surveys***. The frequency of a sanitary survey depends upon the size and classification of the water system. Community water systems receive sanitary surveys on a three-year cycle and non-community water systems receive sanitary surveys on a five-year cycle.

Sanitary surveys are an important element in making sure systems stay in compliance with state and federal drinking water regulations. Sanitary surveys also help the system in their efforts to protect public health by protecting water from any unknown risks. During the sanitary survey, the DNR representative will review the system's compliance and monitoring records and inspect the water system facilities. A copy of the checklists showing areas assessed during a sanitary survey can be found in Appendix A in the back of this manual. Following the inspection, the system owner will receive a written report listing any deficiencies, nonconforming features, recommendations or violations found, and a time frame for correcting the problems.

1.7- DNR NOTIFICATION

Regulations contain many different requirements for water systems to notify their DNR representative depending on the situation and the type of treatment the system uses. The most important notifications the water supplier must remember are:

1.7.1- As soon as possible, but no later than the end of the next business day when:

- There is a water-borne disease outbreak potentially attributed to the water system.
- There is an *E. coli* or total coliform bacteria positive water sample from any certified lab.
- Community water systems experience a loss of pressure in an area affecting 25% or more of the overall distribution system or in an entire pressure zone.

1.7.2- Within 24-hours when:

- There is a failure to comply with any MCL, TTR, or monitoring requirement unless otherwise specified in drinking water codes.
- Nitrate re-sample
- Loss of pressure

1.7.3- Within 10-days of the end of a monitoring period:

- For all results of any monitoring which occurred during the specified monitoring period (month, quarter, year, etc.). The supplier of water is not required to report analytical results to the DNR if the laboratory doing the analysis has already reported the results electronically. The water supplier is responsible for analytical results that are not reported within the required time frames and it is recommended that systems check to make sure that analytical results have been reported by the laboratory.
- For any required monthly reports including the:

- Total monthly pumpage, static and pumping groundwater depth,
- Water quality parameters (if applicable),
- Information on chemical addition (if applicable).

1.7.4- Annually

- Owners of high capacity wells shall record pumpage data on a monthly basis and report the information to the DNR annually using methods and forms provided by the department. Reports of annual pumpage for a given calendar year are due by the first day of March in the following calendar year.

1.8- RECORD KEEPING

The owner or operator of a public water system must retain copies of their records for certain lengths of time. These records must contain certain information and must remain on the premises or at a convenient location near the premises. Although the regulations do specify lengths of time that certain records must be kept, it is recommended that systems keep all records indefinetly for use as a reference by future owners/operators.

1.8.1- Here is a list of some records that public water systems must retain along with the length of time that the records must be kept:

• Actions to correct violations	3 Years
• Public notifications	3 Years
• Bacteriological results	5 Years
• Level 1 and 2 Assessments	5 Years
• Monitoring Assessment forms	5 Years
• Chemical results	10 Years
• Sanitary surveys	10 Years
• Lead and copper data	12 Years

- Monitoring site plans 12 Years

1.8.2- Actual laboratory reports may be kept or the data may be summarized in a table provided that the following information is included:

- The name of the person who took the sample.
- The date, monitoring site ID, location description, and time of sampling.
- Identification of the sample (e.g. routine, check, raw water, entry point, etc.).
- The date of analyses.
- Laboratory and person responsible for performing analyses.
- The analytical method used.
- The results of the analyses.

1.9- PUBLIC NOTIFICATION

The federal government realizes that an important element of public safety is keeping the customer informed about the quality of their drinking water. Two regulations that were enacted to accomplish this goal are the the ***Public Notification Rule*** and the ***Consumer Confidence Report Rule***.

1.9.1- Public Notification Rule

The Public Notification Rule (PNR) specifies how water suppliers must inform their customers in the event of a violation or emergency situation. This rule specifies language, actions, time frames, and methods that must be used to notify the public.

Depending on the severity of the violation or situation, water suppliers have anywhere from 24 hours to one year to notify their customers. Public notices are divided into 3 ***Tiers*** to take into account the seriousness of the violation or situation.

A. Tier 1 Notice (within 24 hours)

For a Tier 1 notice, the water supplier must provide the notice to their customers within 24 hours of learning of the violation or situation. During this time period, the water supplier must also contact the DNR to learn if additional requirements apply. For example, you may be required to provide repeat notices. Examples of situations that require a Tier 1 notice include violation of the MCL for *E.coli* bacteria or nitrate and/or nitrite; a waterborne disease outbreak or any other waterborne emergency.

All public water systems must use one or more of the following methods to provide a Tier 1 notice to their customers:

- Radio
- Television
- Hand or direct delivery
- Posting in conspicuous locations

B. Tier 2 Notice (within 30 days)

For a Tier 2 notice, the water supplier must provide the notice to their customers within 30 days of learning of the violation. The water supplier must also issue a repeat notice every three months for as long as the violation persists. Examples of violations that require a Tier 2 notice include all MCL, Maximum Residual Disinfectant Level (MRDL) and treatment technique violations (except where a Tier 1 notice is required), and monitoring and testing violations elevated to Tier 2 by the DNR.

Community water systems (OTMs) must provide a Tier 2 notice to their customers as follows:

- Mail or hand delivery.
- Any other method to reach persons served if they would not normally be reached by mail or hand delivery.

Non-community water systems (NNs) must provide a Tier 2 notice to their customers as follows:

- Posting the notice in conspicuous locations.
- Mail or hand delivery.
- Any other method to reach persons served if they would not normally be reached by posting, mail or hand delivery.

C. Tier 3 Notice (within 1 year)

For a Tier 3 notice, the water supplier must provide the notice to their customers within 1 year of learning of the violation. Tier 3 notices may be distributed individually or combined into an annual report. The water supplier must also issue a repeat notice annually as long as the violation persists. Examples of violations that require a Tier 3 notice include monitoring and reporting violations (except where a Tier 1 or Tier 2 notice is required).

Community water sytems (OTMs) must provide a Tier 3 notice to their customers as follows:

- Mail or hand delivery.
- Any other method to reach persons served if they would not normally be reached by mail or hand delivery.
- In the Consumer Confidence Report, if the violations requiring a Tier 3 notice are less than 1 year old.

Non-community water systems (NNs) must provide the notice to their customers as follows:

- Posting the notice in conspicuous locations.
- Mail or hand delivery.
- Any other method to reach persons served if they would not normally be reached by posting, mail or hand delivery.

D. Tier Determination

If you have a violation or situation and you are not sure which type of notice is needed (Tier 1, Tier 2 or Tier 3) or what needs to be done, make sure to contact your DNR representative right away. Remember, "**when in doubt, call the DNR and find out**."

E. 10 Elements of a Public Notice

Each public notice must include the following 10 basic elements:

1. Description of the violation or situation.
2. When the violation or situation occurred.
3. Any potential health effects including standard health effects language.
4. The population at risk.
5. Whether alternative water supplies (e.g. bottled water) should be used.
6. Action consumers should take, if any.
7. What the system is doing to correct the problem.
8. When the system expects to resolve the problem.
9. The name, business address and phone number of the system owner or operator.
10. A statement to encourage distribution of the notice to others.

F. After Issuing a Public Notice

The water supplier must send a signed copy of the notice to their DNR representative within 10 days after providing the notice to their customers. Failure to do so will cause a public notice violation.

1.9.2-Consumer Confidence Report Rule

The Consumer Confidence Report (CCR) is a report that community water systems (OTM and MC systems) must provide to their customers annually. The report is an important public relations tool that shows consumers the efforts made by the water supplier to provide safe water. It is designed to inform the consumers of the quality of the water they are drinking. It must include the following information:

- The source of water (e.g. groundwater or surface water).
- The name and phone number of the person that customers may contact if they have questions about the report or their water.
- The time, date, and location of any meetings that customers may attend.
- Definitions of the terms and abbreviations used in the report.
- Contaminants detected in the water (if any) and the levels found.
- Information on the health effects of the contaminants detected in the water and where additional information is available.
- Explanation of any violations, length of violations, potential health effects, and steps taken to address the violations.
- Compliance with other drinking water regulations.

The report must be made available to every customer of the water system ***before July 1st of the following year*** and must also be available in alternative languages if a significant number of the customers are non-English speaking.

Once the CCR has been completed and distributed to the customers, the water system is required to complete a CCR Certification form detailing the efforts made to make the report available to the customers. Send the signed certification form and a copy of the CCR to the DNR by July 1st .

Instructions and a template for creating a customized CCR for your system are available on the DNR website by accessing your system page and clicking on the heading for “Consumer Confidence Report”.

1.10- VIOLATIONS

Violations of regulations for public drinking water systems can generally be placed in one of three categories. The violation categories are: ***water quality violations, monitoring and reporting violations, public notification violations and water system violations***. A listing of the regulations for public water systems in Wisconsin can be found in the Wisconsin Administrative Code Chapters NR 809, NR 810, NR 811 and NR 812.

1.10.1- Water Quality Violations

Water quality violations occur when the level of a contaminant exceeds its MCL or if a system fails to follow a treatment technique requirement. The severity of the violation, and the resulting action that needs to be taken by the owner or operator, is determined by the risk posed to public health. Minimum required actions may include public notification and a time frame for compliance. If the violation poses a significant risk to public health, immediate notification, immediate treatment, and/or fines for non-compliance may apply.

1.10.2- Monitoring & Reporting Violations

Water monitoring and reporting violations (also called M/R violations) occur when the owner or operator of a public water system fails to meet their monitoring and reporting requirements. Monitoring schedules are mailed to all OTM and NN systems at the beginning of each year. These schedules list the contaminants that must be monitored and the time frame in which the monitoring must occur. A list of certified laboratories is included with the monitoring schedule. It is the responsibility of the system owner to make sure that all samples are collected at the appropriate monitoring site, within the appropriate time frame, analyzed by a certified laboratory and the monitoring data is submitted to the DNR within 10 days of the end of the specified monitoring period. Failure to complete **any** of these actions can cause a monitoring and reporting violation and may result in increased monitoring, public notification and/or fines.

1.10.3- Public Notification Violations

As described earlier in this manual, failure to notify the public of certain violations or concerns with the system and water quality is a violation of state and federal regulations. This includes a variety of factors that may affect the health of those consuming the water and includes notifications such as public notices, Boil Water Notices, lead and copper sample results, Consumer Confidence Reports and failure to comply with written compliance orders.

1.10.4- Water System Violations

Water system violations occur when a water system fails to meet code requirements for water system construction, operation, water pressure and flow. In most cases, violations of requirements for existing facilities are identified in sanitary surveys conducted by the DNR representative. Other violations occur when a water system owner fails to obtain the necessary DNR approval for facility upgrades, construction, and installation of water treatment.

1.10.5- Enforcement

Violations of water system requirements will generally result in a compliance order listing the specific actions that must be taken and the time frame to complete the actions. The system owner or operator may also face enforcement actions, including fines and/or penalties, for any violation of drinking water regulations such as knowingly falsifying monitoring or reporting data or failure to take corrective action of a water system violation.

1.11- CAPACITY DEVELOPMENT

Capacity development is a program that aims to help public water systems strengthen their ability to supply safe drinking water now and into the future. The program focuses on assisting system owners and operators, particularly small water systems, with improving their technical abilities, managerial skills, and financial resources to comply with the federal Safe Drinking Water Act (SDWA) requirements.

One of the goals of the Capacity Development Program is to help water systems improve operations and, most importantly, avoid contamination. The Capacity Development Program was authorized by the 1996 amendments to the SDWA, which established a strong emphasis on preventing contamination. No new community or non-transient non-community water system may commence operation unless the owner of the proposed water system first demonstrates to the satisfaction of the DNR that the water system has and will maintain adequate financial, managerial and technical capacity to meet state and federal requirements.

Capacity, in this sense, does not mean just having enough safe water to drink. Rather, it means that a water system has the capability to ensure continuous delivery of safe drinking water to its customers now and into the future.

Capacity can be broken down into three interrelated areas. They are ***technical, managerial,*** and ***financial*** capacity. Each area is further defined as follows:

1.11.1- Technical Capacity

Technical capacity is the physical and operational ability of a water system to meet the SDWA requirements. It refers to the physical infrastructure of the water system, including source water adequacy, infrastructure adequacy (including wells and/or source intakes, treatment, storage, and distribution system), and the ability of water system personnel to implement the necessary technical knowledge to safely operate the system. As an important part of technical capacity, water system operators are required to attend a minimum of 6 credits of continuing education every three years to broaden their technical knowledge as well as keep them abreast of any changes or amendments to drinking water regulations. Being up to date on the most current drinking water regulations is critical to a water system's technical capacity.

1.11.2- Managerial Capacity

Managerial capacity refers to the water system's institutional and administrative capabilities. It includes the management structure of the water system, ownership accountability, hiring, managing, and training of water system staff, and the overall water system organization. Identifying and clearly communicating who is responsible for sampling and monitoring & reporting for a water system is essential to managerial capacity.

1.11.3- Financial Capacity

Financial capacity refers to the financial resources of the water system. These resources include: revenue sufficiency (taking into account the need for future replacement of existing equipment), credit worthiness (the ability of the system owners to obtain and repay loans for needed capital improvements), and fiscal management (collection and management of sufficient revenues to safely operate and maintain the water system). Asset management is an effective tool for guiding financial planning and spending in both the short and long-term. Awareness of the state of a water system's assets can greatly enhance financial capacity, by allowing effective planning for necessary system improvements, repairs, and emergencies.

1.11.4- Wisconsin's Capacity Development Program

To assess these three areas, the EPA required the DNR to create a Capacity Development Program. The program was finalized in August 2000. It is meant to be a proactive means of evaluating and assisting water systems before problems occur, instead of dealing with problems after-the-fact. When it comes to maintaining the capacity of a water system, the system owner, manager, and operator(s) are all responsible.

The first phase of Wisconsin's Capacity Development Program is to evaluate the "capacity" of each public water system. For new public water systems, the DNR evaluates system capacity prior to construction. For existing water systems, the DNR uses its inspection processes, namely sanitary surveys, to assess capacity. If capacity development problems are identified, the DNR uses various "tools" or activities to assist water systems. These tools will help public water systems comply with the SDWA requirements. Some of Wisconsin's capacity development tools include:

A. **One-on-one technical assistance from state and local government staff:** Staff from municipal, county, and state government offer assistance to water systems owners and operators to help them understand the regulations.

B. **Technical assistance program:** The DNR works with contractors to provide technical assistance for OTM and NN systems. The contractors provide one-on-one assistance to water system operators, covering a variety of SDWA topics and issues.

Review Questions for Drinking Water Regulations

Name of the act that sets standards, also known as MCLs, for drinking water quality?

What is the state agency responsible for public drinking water regulations in Wisconsin?

In general, what determines if something is a “public” water system?

What is the main difference between a community water system and a non-community water system?

What are the two sub-categories of community water systems? What are the two sub-categories of non-community water systems?

What WI Administrative Code provides the certification requirements of water system operators? How many hours of continuing education are required on what frequency?

When are water system owners are responsible for obtaining plan approvals from the DNR?

What is the name of the on-site inspections conducted by DNR representatives to make sure systems are in compliance with drinking water regulations? What is the frequency of community inspections? Non-community inspections?

What is the main difference between primary and secondary drinking water standards?

What are the two regulations enacted that are aimed at the customer’s right to know about their water quality?

What is the name of the rankings established by the Public Notification Rule based on the severity of violations?

How often are Consumer Confidence Reports required? What is the date the report must be made available to customers?

If a system exceeds an MCL, what type of violation will be received?

What is an M/R violation? What is a public notice violation? What are the three areas taken into account when assessing the capacity of a water system?

What is an example of an effective tool for guiding financial planning and spending in both the short and long-term for a water system?

What was the rationale behind developing the Capacity Development Program?

Who is responsible for maintaining the capacity of a water system?

Chapter 2- Source Water

For many years, when people wanted water, they simply picked a spot and drilled, dug, or pounded a well into the ground with little thought other than getting enough water to suit their needs. Those days are gone. These days, when people are looking for water, as much consideration must be paid to the quality of the water as the quantity. This chapter explains the water cycle, water sources, water quality, and its characteristics. It also explains the actions well owners can take to protect the quality of the water they already have.

2.1- THE HYDROLOGIC CYCLE

The hydrologic cycle is the continuous movement of water through the environment. Water undergoes physical, chemical, biological and radiological changes due to different factors in the environment that affect its quality and characteristics.

2.1.1-Evaporation and Transpiration

Illustration 2-1 shows the hydrologic cycle. It starts with water entering the atmosphere through ***evaporation*** from surface water bodies such as ponds, lakes, rivers, and oceans. Evaporation is the changing of water from a liquid to a gaseous state called ***water vapor***. Water also enters the atmosphere through ***evapotranspiration*** from plants**.** As plants take up water through their root systems, water moves through the plant and returns to the atmosphere through tiny pores in the leaves.

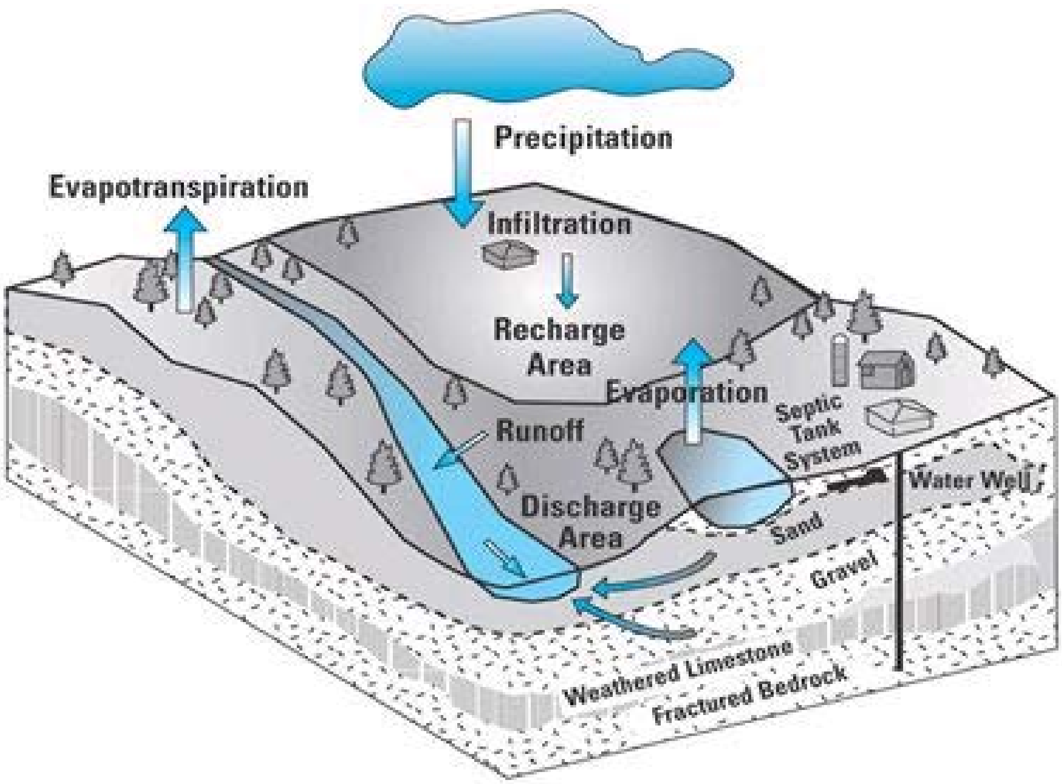


Illustration 2-1

2.1.2- Condensation

As water vapor enters the atmosphere, it changes from water vapor to water drops. This process, caused by the cooling of water vapor, is called ***condensation***. A good example of condensation is the liquid that forms on the outside of a cold glass of water on a hot summer day. As condensation occurs in the atmosphere, clouds are formed. Clouds are made up entirely of tiny water drops or ice crystals.

2.1.3- Precipitation

As clouds absorb more and more water, they reach a point where they can hold no more and the water falls to the earth. This is called ***precipitation***. In warm temperatures, it falls as drizzle or rain. In cold temperatures, it falls as hail, sleet, or snow.

2.1.4- Infiltration, Runoff and Percolation

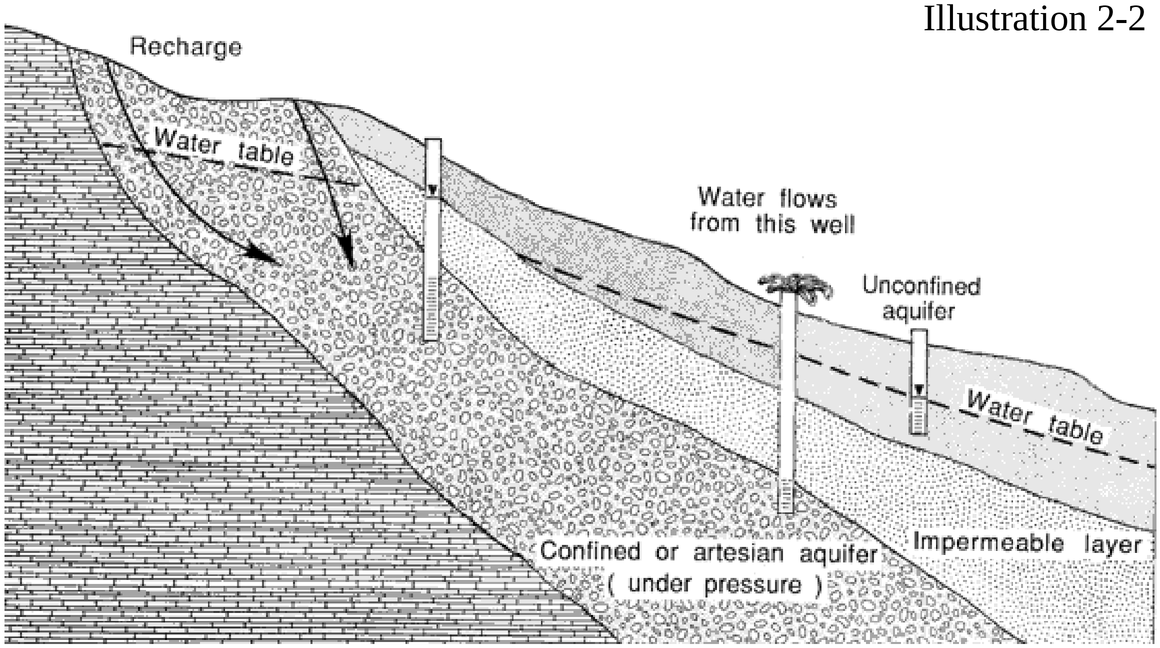
Once water reaches the earth's surface, some of it is absorbed by the soil. The process of water moving into the soil from the ground surface is called ***infiltration***. Once water infiltrates into the soil, some is taken up by plant roots and re-enters the atmosphere through transpiration. Some of the water continues to move further down through the soil. This is called ***percolation***. Some may return to the surface through the ***capillary action*** of the soil. Capillary action is the movement of water through tiny pores in soil due to the molecular attraction between the water and the soil. An example of capillary action is what occurs when you put a cloth partially into a glass of water. Through capillary action, the water moves up the cloth, above the water level in the glass.

When soil can no longer hold any more water, it becomes ***saturated***. If more precipitation falls, some of the water begins to flow across the ground. This is called ***runoff***. Runoff flows into creeks, streams, rivers, and lakes and eventually re-enters the water cycle through evaporation.

2.1.5- Aquifers and Groundwater

Illustration 2-2 shows an aquifer and groundwater system. The water that infiltrates into and percolates down through the soil and rock eventually reaches a saturated zone called the ***water table***. Below the water table is an ***aquifer***. An aquifer is a water-bearing soil or rock formation below the earth's surface. The water contained in the aquifer is ***groundwater***. There can be more than one aquifer below the surface in any one location. Aquifers fall into two broad categories, ***unconfined*** and ***confined***.

Illustration 2-2



2.1.6- Unconfined and Confined Aquifers

An unconfined aquifer is located in a permeable formation where the water table is free to rise and fall, depending on factors such as the amount of rainfall and recharge. Confined aquifers or artesian aquifers are situated below an ***impermeable layer*** (confining layer) such as shale or clay. If an impermeable layer exists above the surrounding water table, a perched aquifer may form.

2.1.7- Consolidated and Unconsolidated Formations

Unconfined aquifers are often made up of sand and gravel formations. These formations are called ***unconsolidated*** because they are made up of loose materials that are not cemented together. Most unconsolidated formations are made up of glacial or river materials deposited millions of years ago. A ***consolidated formation*** consists of firm, coherent rock, such as sandstone, granite, dolomite, or limestone. Most consolidated formations were deposited hundreds of millions of years ago.

2.1.8- Springs and Artesian Wells

If a confined aquifer gets its water from a source at a higher elevation, it may be under pressure. If a well is cased through the confining layer, water in the well may rise above the aquifer - a further indication that it's under pressure. A well placed into this aquifer is called an ***artesian*** well. If water flows out of the well without being pumped, it is called a ***flowing artesian*** well (see Illustration 2-2).

Springs may form when an impermeable layer such as clay intersects a hillside. As water percolates down through the soil and intercepts the clay layer, the water flows along the top of the clay layer until it discharges on a hillside. Springs may also form when water-bearing fractured rock intersects a hillside.

2.1.9- Water Movement in Aquifers

Gravity and pressure control the movement of groundwater in aquifers. Like surface water, groundwater flows downhill. The natural movement of groundwater is from a point of high elevation (uplands) to a low one (lowlands), where it eventually discharges to a lake, stream, wetland, or spring. Near the coast, groundwater may discharge to the ocean.

Geology controls the rate of groundwater movement. In sand and gravel aquifers, groundwater may move hundreds of feet per year. In an aquifer made up primarily of silt and clay, groundwater moves only a few inches per year. Most groundwater moves a few feet per year. There are many factors that affect how groundwater moves including the permeability of the formation, fractures in the rock, the size and location of the recharge areas, and wells pumping from the aquifer. ***Permeability*** refers to the ability of rock or soil to transmit water. It is possible for groundwater to move at different speeds at different depths in the same aquifer.

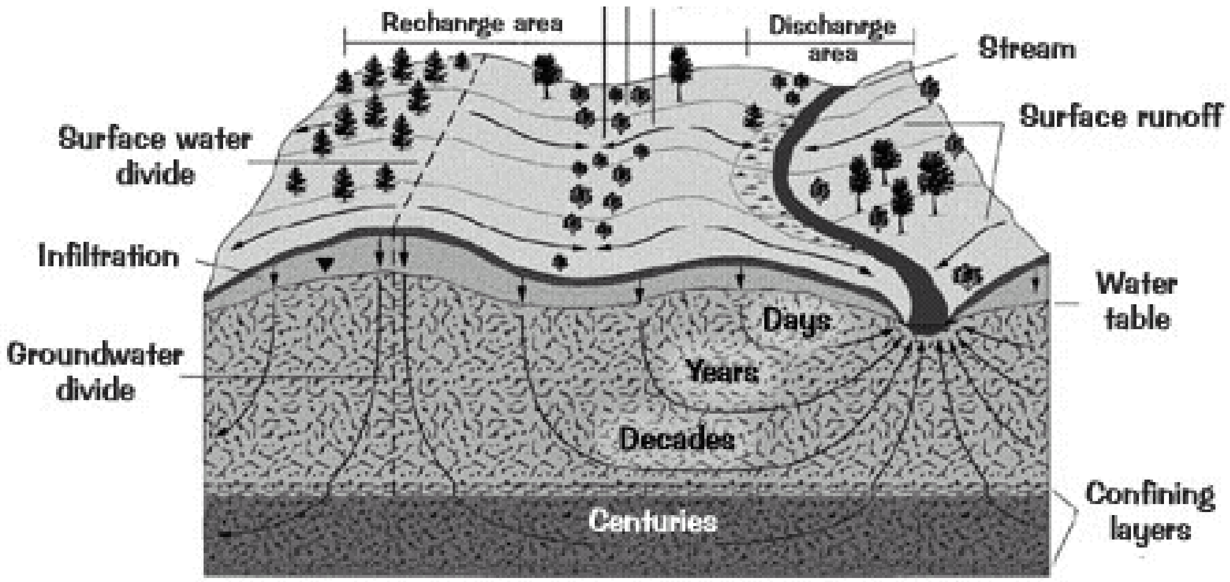


Illustration 2-3

2.2- DRINKING WATER SOURCES

Water exists in the environment in different forms and locations. The ***source*** of drinking water refers to where it's taken from. There are three main sources of drinking water in Wisconsin: ***surface water***, ***groundwater***, and ***groundwater under the influence of surface water***.

2.2.1- Surface Water

Water that is obtained from lakes, reservoirs and rivers is called surface water. Surface waters are very susceptible to contamination. You name it **—** manure, gasoline, pesticides, fertilizers, industrial chemicals, bacteria, air pollution **—** it can enter surface waters. Because of their high susceptibility to contaminants, surface water sources must meet strict monitoring and treatment requirements.

While there are relatively few surface water systems in Wisconsin, they supply more water to than any other type of system. They are typically used by large cities that need a large volume of water to meet their needs.

2.2.2- Groundwater

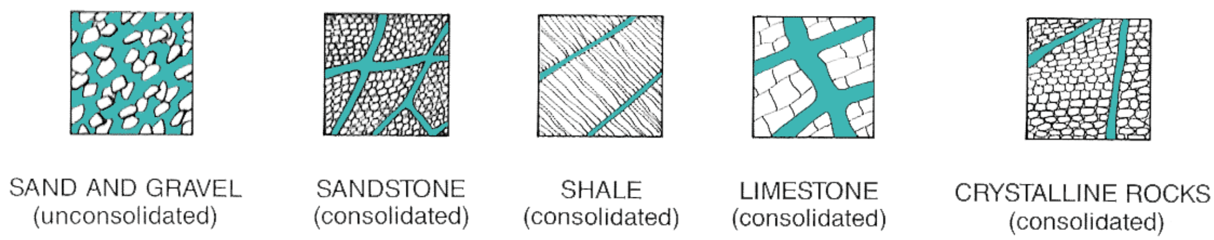
The water that is obtained from aquifers is called groundwater. Groundwater is generally less susceptible to contamination than surface water. Groundwater's susceptibility to contamination depends on the type and thickness of soil and rock layers, depth to the groundwater, and the type of contaminants. Some soils are very good at filtering out contaminants. Others are not. Groundwater in the central sands area and karst features of Wisconsin is very susceptible to contamination. In contrast, areas with thick, rich soil and a good depth to groundwater are generally less susceptible to contamination. In some areas of the state, groundwater may become contaminated with naturally occurring minerals in the soil and rock such as arsenic, lead, radium and uranium along with radon gas which comes from the natural breakdown of uranium. Groundwater systems generally have less restrictive monitoring and treatment requirements than surface water systems.

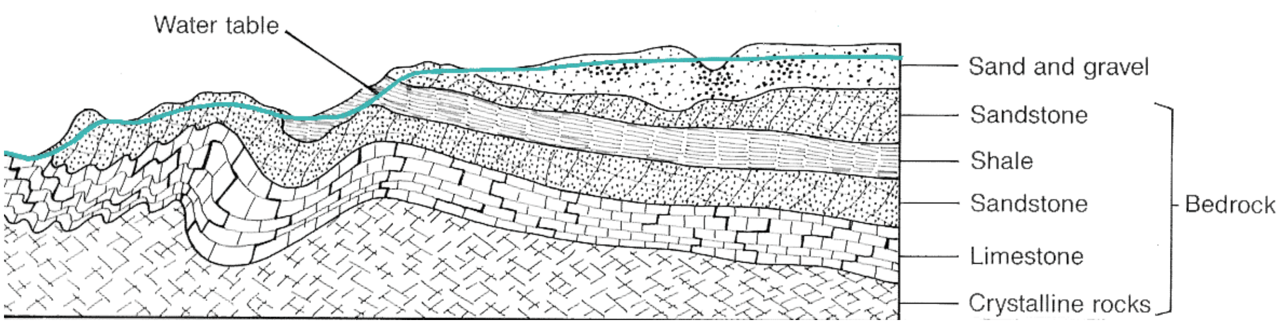
2.2.3- Groundwater Under the Influence of Surface Water

Water that is obtained from an aquifer that may be intermixed with surface water is called "groundwater under the influence of surface water". This situation may occur when a well is placed next to a lake or river. As the well is pumped, some of the water from the lake or river enters the groundwater, which, in turn, can reach the well. In other words, the groundwater has a connection to the surface water. This connection makes the groundwater susceptible to the same types of contaminants as the surface water. Groundwater under the influence of surface water is covered by the same regulations as surface water systems.

<u>2.3- GROUNDWATER SOURCES IN WISCONSIN</u>

The state of Wisconsin has a varied geology, which allows groundwater to exist in a variety of formations and aquifers. In Wisconsin, there are four principal aquifers: the ***sand and gravel aquifer***, the ***eastern dolomite aquifer***, the ***sandstone and dolomite aquifer***, and the ***crystalline bedrock aquifer***. These aquifers were formed by a variety of geologic processes including igneous intrusions, ancient oceans, and more recently, glaciers that covered 2/3 of the state during the Ice Age. See Appendix B for detailed information on geological sections of Wisconsin's aquifers.





2.3.1- The Sand and Gravel Aquifer

The sand and gravel aquifer covers most of the state, except for parts of southwest Wisconsin. Glaciers did not cover the southwestern portion of the state. This part of the state is known as the "Driftless Area". In Wisconsin, many sand and gravel formations are the result of the glacial movement and materials that were deposited as the ice melted. These shallow aquifers can be more than 300 feet thick in places and provide large volumes of groundwater. Because these sand and gravel formations are at or near the land surface and have little filtering capacity, they may be very susceptible to contamination.

2.3.2- The Eastern Dolomite Aquifer

The eastern dolomite aquifer, formed around 400 million years ago, is a narrow strip of Niagara dolomite over Maquoketa shale that exists along the easternmost part of the state, from Door County to the Illinois border. In some areas, the dolomite bedrock occurs at or near the surface leaving the shallow groundwater especially susceptible to contaminants. As dolomite is similar to limestone, groundwater resides in the interconnecting cracks and crevices that are part of this formation. Thus, the amount of water that can be obtained from a well in the eastern dolomite aquifer is largely dependent on the cracks and crevices it intersects. The Maquoketa shale is an impermeable rock layer formed from clay. It serves as a barrier between the eastern dolomite aquifer and the sandstone and dolomite aquifer below it.

2.3.3- The Sandstone and Dolomite Aquifer

The sandstone and dolomite aquifer formed from 425 to 600 million years ago. It covers most of the state, except in north central Wisconsin. Along the eastern edge of the state, this aquifer exists below the Maquoketa shale. Throughout the rest of the state, it lies below the sand and gravel formations. As opposed to dolomite, the sandstone in this formation can produce substantial amounts of water, making it the principal bedrock aquifer for wells in the southern and western areas of the state.

2.3.4- The Crystalline Bedrock Aquifer

The crystalline bedrock aquifer formed from 600 million to 4 billion years ago. It is made up of a granite-type crystalline structure that underlies the other aquifers throughout the entire state. As in the dolomite formations, water in the crystalline bedrock is contained mostly in cracks and crevices. However, fewer cracks and crevaces in the crystalline bedrock aquifer often limit its ability to serve as a source of groundwater.

2.4- WATER QUALITY AND CHARACTERISTICS

The quality and characteristics of water are influenced by many factors including where it comes from and what it’s exposed to as it travels through the hydrologic cycle. Water quality and characteristics are important to consider when choosing a water source. The four general categories of water characteristics are ***physical***, ***chemical***, ***biological*** and ***radiological***.

2.4.1- Physical Characteristics

A. Water ***temperature*** will affect how it tastes, how easily it dissolves solids and whether it’s effective for other uses such as cooling. Generally, surface water sources are warmer than groundwater sources.

B. ***Turbidity*** is the cloudiness caused by matter or particles suspended in the water. This matter may include natural organic material, which is an aesthetic concern, but it may also include algae, bacteria or microorganisms, which can cause serious health problems. Usually, the turbidity of groundwater is near zero due to the filtering characteristics of soil, while the turbidity of surface water is typically higher.

C. The ***color*** of water can be an important characteristic. Although color may be present in groundwater due to certain minerals or natural organic compounds, it is primarily of concern for surface water sources. Color is typically caused by the decomposition of organic materials such as leaves and plant remains. A change in water color may indicate the presence of contaminants that may be harmful to public health.

D. The ***taste*** and ***odor*** of water can be affected by chemicals, minerals, decaying matter or dissolved gases. The most common cause of odor in drinking water is the presence of hydrogen sulfide, iron or sulphur-reducing bacteria. In a distribution system, the corrosion of pipe materials can also cause taste and odor. Even though taste and odor are more of an aesthetic concern than a health related one, their presence may be indicative of other contaminants that may be harmful to public health.

2.4.2- Chemical Characteristics

The chemical characteristics of water can be broken down into two main groups: organic and inorganic. Organic chemicals are carbon based, whereas inorganic chemicals are not.

A. **Organic**

Organic chemical characteristics in water come from the breakdown of naturally occurring materials, introduction of contaminants from human activities, and the reactions that occur during water treatment and distribution. The most common organic chemicals come from the breakdown of natural materials such as leaves and plants, aquatic decomposition and other natural by-products. However, organic solvents, pesticides, herbicides and other personal, commercial and industrial products are becoming more common in drinking water.

B. Inorganic

Inorganic chemical characteristics include measures such as ***pH***, ***hardness***, ***dissolved oxygen***, ***dissolved solids***, and ***electrical conductivity***. These characteristics are explained in more detail below.

1. pH

The pH of water is the level of its acidity or alkalinity. The pH scale is a numerical scale from 0 to 14. A pH of 7 is considered neutral. Generally, a pH below 7 is considered acidic, and a pH above 7 is considered alkaline. Acidic water has a tendency to corrode materials it comes into contact with. Conversely, alkaline water has a tendency to leave a scale buildup on the inside of plumbing and fixtures.

2. Hardness

Hard water contains high amounts of calcium and magnesium ions. ***Hard water*** can be a problem because it requires more soap when washing and can lead to a buildup of calcium and magnesium on the inside of plumbing and fixtures. This is especially true when hard water is heated, such as in a water heater. However, this scale buildup can have the beneficial affect of preventing lead and copper from leaching from plumbing and fixtures into the water.

3. Dissolved Oxygen

Dissolved oxygen, or DO, is a common dissolved gas in water. Dissolved oxygen can enter the water from the air (aeration), from plants (photosynthesis), or be introduced as part of a treatment process such as “air stripping”. High levels of dissolved oxygen in water can cause it to be corrosive, especially to metallic surfaces.

4. Dissolved Solids

Water is sometimes referred to as the “universal solvent” because it tends to dissolve minerals that come in contact with it. Therefore, it may contain a variety of dissolved minerals. Some of these minerals, such as arsenic, barium, lead, and mercury can adversely affect human health, while others such as iron and manganese, affect the aesthetic quality of water. The sum of minerals dissolved in water is referred to as ***total dissolved solids*** or TDS. Water with higher levels of dissolved solids can cause problems with taste, odor, hardness, corrosion and buildup. It can also cause problems when used in manufacturing processes.

5. **Electrical Conductivity**

The electrical conductivity of water is its ability to conduct an electric current. Ions dissolved in the water cause electric current to flow. One way to determine the level of total dissolved solids, or TDS, in water is to measure its electrical conductivity. Water with less dissolved solids will conduct less electricity than water with high levels of dissolved solids.

2.4.3 Biological Characteristics

For drinking water, perhaps the most important water characteristic is its biological quality. Microbial contaminants such as bacteria, viruses and microscopic organisms pose the greatest health risk challenge for water system owners and operators. Mild to moderate illness lasting days to weeks can result from short-term exposure to microbial pathogens. More serious health problems, even death, can result when people with weakened immune systems are exposed to pathogens. Microbial pathogens are present in human and animal feces, which can, in turn, contaminate drinking water.

A. **Bacteria**

Bacteria found in water, such as coliform, salmonella, *Legionella*, and *E. coli*, can be naturally occuring but most often are attributed to human and animal wastes. The total coliform group of bacteria is found nearly everywhere in the environment, except in clean water. Some specific types of coliform bacteria are also associated with the digestive tracts of humans and many animals. While most forms of coliform bacteria are harmless, their presence in drinking water can indicate that either the water source or the distribution system has been contaminated by an external source. As such, the presence of total coliform in drinking water may be an indication that other more harmful bacteria, such as *E. coli*, are present.

Fortunately, most forms of bacteria found in drinking water can be treated effectively with modern disinfection methods such as chlorine. However, when a system finds coliforms in its drinking water, it may indicate that the water system is not working properly. In these cases, finding and eliminating the source of coliform bacteria, disinfection equipment repair, flushing or upgrading the distribution system, and enacting a source water protection program may be necessary.

B. **Viruses**

Viral infection of drinking water supplies is another major concern in the protection of public health. Examples of water-borne viruses include enterovirus, rotovirus and hepatitis. As with bacteria, the presence of viruses in drinking water may be associated with human wastes. If viruses are detected in drinking water, immediate steps must be taken to rectify the problem.

C. **Microscopic Organisms**

Although most disease causing microscopic organisms, or ***protozoans***, are not naturally found in water, they can survive in water for a period of time. Examples of such organisms include ***Giardia*** and ***Cryptosporidium***. Their presence is also attributable to human and animal wastes, but unlike most bacteria and viruses, they can be particularly difficult to detect and treat in drinking water. That's because they are resistant to chlorine and can easily pass through inefficient filtration devices. Proper disinfection and/or filtration, system maintenance, and regular system upgrades are essential to protecting human health from these pathogens.

2.4.4- Radiological Characteristics

Although the presence of radiological elements, or ***radionuclides***, in drinking water may be attributed to human activities, they are most often a result of dissolution of naturally occurring radioactive elements in rock formations such as granites. Examples of radionuclides found in drinking water include radium 226, radium 228, uranium and radon. When consumed for extended periods of time, these radioactive contaminants are known to cause cancer in humans.

2.5- SOURCE WATER PROTECTION

For many years, people assumed that there was an unending supply of clean, safe water. However, we now know that many human activities can contaminate groundwater. That's why it's so important to prevent contamination whenever possible. Fortunately, there are many steps water suppliers can take to protect the quality and quantity of their source water.

2.5.1- Water Conservation

One way to protect the quality and quantity of water is to limit the amount that is used. This is called ***water conservation***. Although the earth contains adequate resources of water, it is disproportionately distributed. In some areas of the state, the amount of water available is decreasing at an alarming rate. As these supplies dwindle, either new wells must be drilled or existing ones drilled deeper. If you drill deeper, natural contaminants like arsenic and radioactivity may be encountered. If you pump too much water from existing wells, pesticides, gasoline or other contaminants may be drawn in from nearby sources. Any way you look at it, water conservation is a wise investment.

There are many ways to conserve water such as promoting the use of low-flow faucets, toilets and showerheads. Industries can also be encouraged to recycle and reuse water in their processes. Perhaps the most effective means of promoting water conservation is public education. As customers become aware of the potential health risks of contaminated water and the high costs of treatment, they will learn to use water wisely and protect it as a valuable resource.

2.5.2- Wellhead Protection

One way to protect the quality of water provided by your well is to limit the amount of contaminants that enter its recharge area. Although not currently required for other than municipal (OTM) and nontransient noncommunity (NN) wells, a Wellhead Protection Plan can be used to ensure you have a long-term source of clean groundwater. Wellhead protection planning involves identifying the area contributing water to the well (recharge area), inventorying potential contaminant sources within that area and developing a strategy or plan to protect the well from contamination. Your ***Monitoring Assessment*** contains the recharge area delineation and source inventory information that can be used to develop a wellhead protection plan to protect your well. This might include working with nearby businesses or activities that might impact groundwater or conducting a public education program to inform people about activities that may contaminate the groundwater.

2.5.3- Monitoring Assessment

Monitoring Assessments, sometimes called Vulnerability Assessments, are updated every three years in order to identify possible sources of contamination in the area of your well. Completion of a Monitoring Assessment is important for water systems because it can provide information to the DNR that they can use to provide monitoring waivers for certain contaminants where no potenital contaminant sources exist and\or where a well is not vulnerable to contaminants. Waivers can reduce or eliminate monitoring for certain contaminants and reduce monitoring costs to public water suply owners..

2.5.4- Well Filling and Sealing

Wells are a direct conduit to groundwater. It is important to properly fill and seal wells that are no longer in use, are contaminated, or may present a health or safety issue because they don’t comply with existing codes. This includes having the work performed by a person that meets the requirements in the Administrative Code. Also referred to as ***Well and Drillhole Filling and Sealing***, Wisconsin’s requirements for filling & sealing wells are listed in NR 810, 811 and 812 of the Wisconsin Administrative Code.

Review Questions for Source Water

What is the name of the cycle that explains how water moves through the environment?

What is the name of the process by which water changes from a liquid to a gaseous state?

Name the process where water moves over and across the soil.

What is the difference between a permeable formation and an impermeable layer?

What factors can affect how water moves through an aquifer?

What is the difference between a confined aquifer and an unconfined aquifer?

What is the difference between a consolidated formation and an unconsolidated formation?

Name the three sources of drinking water.

Name the four main aquifers in Wisconsin.

Name the four main categories of water characteristics.

What are the four main physical characteristics of water?

What is the most common source of organic chemicals in water?

What chemical characteristics of water can affect its corrosivity?

What two biological contaminants in water are associated with human and/or animal wastes?

Name two protozoans that can be found in drinking water.

What is the most common health affect associated with radiological contaminants in drinking water?

Name four actions that an owner/operator can take to protect the quality of their water source.

Chapter 3- Wells

3.1- WELLS

Virtually all small water systems in Wisconsin obtain their water from a well. Wells are defined as any opening into the ground to obtain water, where the depth of the opening is greater than it is wide, extending more than 10 feet below the ground surface and constructed for the purpose of obtaining groundwater. Depending on the depth to groundwater, the amount of water needed, and the water quality, code-compliant wells can range from 25 feet to thousands of feet deep. Most public wells in Wisconsin are 100 feet to 500 feet deep, depending on the formation used to obtain water. The construction methods used determines the well type – dug, driven, and drilled.

3.1.1- Dug Wells

Dug wells are typically constructed in areas with very high groundwater levels (see Illustration 3-1). They utilize a constructed box or circular structure which allows water to seep into the well, where it can then be pumped out for use. These wells were widely used before modern drilling equipment was invented. An example of a common dug well is the "Wishing Well" with the rope and bucket attached to a hand crank. These wells often pose a safety hazard and are prone to contamination. The DNR strongly discourages their construction or use; hence they are no longer very common in Wisconsin. Dug wells may not be constructed without written approval from the DNR.

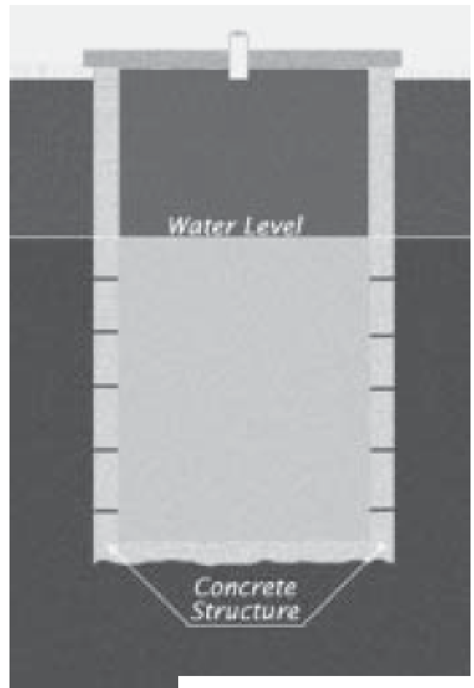


Illustration 3-1

3.1.2- Driven Wells

Driven wells are constructed by driving a pipe with a point and screen into the ground (see Illustration 3-2). Because they are often installed in areas with sandy soils, they are also called "sand-point" wells. Due to the limitations on how deep they can be driven, they are generally used in areas that have a shallow groundwater level. In certain areas of Wisconsin, driven wells are still common for single-family residential wells. They are not allowed for use by community or nontransient noncommunity water systems and are only allowed for private residences and transient non-community system wells.

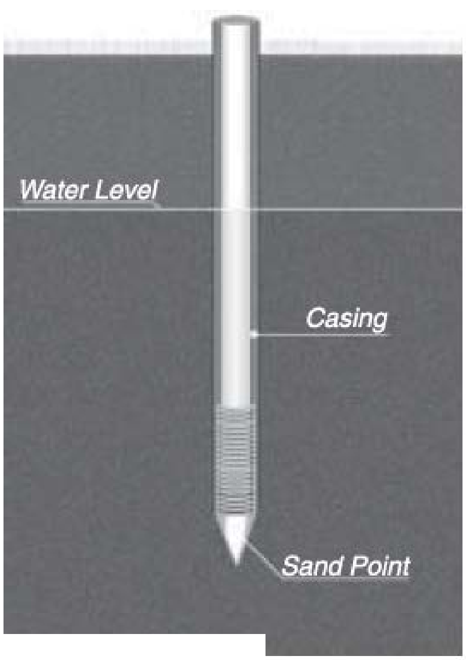


Illustration 3-2

3.1.3- Drilled Wells

Almost all modern wells constructed for public use are drilled wells (see Illustrations 3-3 and 3-4). They can be drilled using many different methods, but in Wisconsin the two most common methods are the ***cable-tool (percussion) method*** and the ***rotary-drilling method***.

A. Cable-Tool (Percussion) Method

The cable-tool method uses a drill bit which pounds its way into the ground, crushing the soil, material and rock it encounters. Periodically, the bit is lifted and the crushed material is cleared from the drill hole using a bailer. The bailer is a section of pipe, smaller in diameter than the casing, with a check valve at the bottom. As the bailer is lowered, the check valve is open and it fills with the crushed material. As it is lifted, the check valve closes and the material is lifted to the surface and discarded.

B. Rotary Drilling Method

The rotary drilling method uses a spinning drill bit that is lowered into the ground. Water or air is pumped down, either through the outside or inside of the drill bit. The water or air cools the bit and carries the drilled materials to the surface. When constructing wells through loose materials or soft bedrock, clay can be mixed with the drilling water to provide a "slurry" that removes the drill cuttings and keeps the drillhole open and the drill bit lubricated.

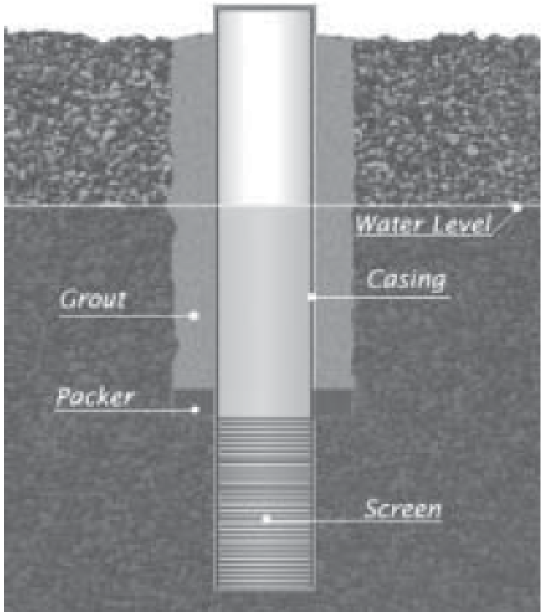


Illustration 3-3

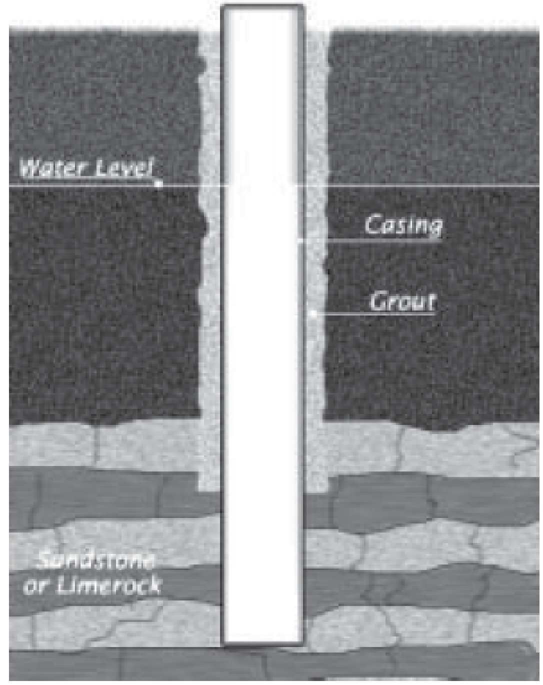


Illustration 3-4

3.1.4- Well Casing

Steel casing is installed in wells to keep the hole from caving in (see Illustrations 3-3 and 3-4). The casing lengths are welded or threaded and coupled together to form a continuous casing from the surface to the sand and gravel formation or bedrock formation below. Casing not only serves to keep the well-hole open, but it also prevents contamination from entering the well and groundwater. It helps ensure that the well will produce bacteriologically and chemically safe water. In Wisconsin, casing pipe depth requirements are based on whether the well is constructed in a sand and gravel formation or bedrock. Because the top layers of some rock formations can be somewhat porous, the casing is installed into the rock formation to a depth where solid bedrock is encountered.

3.1.5- Grout

Openings or voids may be created around the casing during the drilling process (see Illustrations 3-3 and 3-4). These voids, or annular spaces, are filled by the driller with a type of cement called "***grout.***" The grout acts as a seal to prevent contamination from moving down the casing to groundwater and also acts to stabilize the formation and protect the exterior of the casing from corrosion. For wells drilled into bedrock formations, the grout is installed from the surface to the bottom of the casing, whether it is at the top of the bedrock formation or deep into it.

3.1.6- Gravel-Pack

In wells where soft or very fine-grained sands are encountered, a gravel pack is used to prevent the sand from entering the well. For a gravel-pack well, a larger borehole is drilled and a screen is attached to the casing. A screen is a filtering device that allows water to enter a well, but not sediment. In a gravel-pack well, small stone or gravel is installed around the screen and casing. This gravel allows water to freely enter the well during pumping, but it prevents the sand formation from entering the well.

3.1.7- Vents

Wells may have vents to allow for the displacement of air during the pump starting and stopping cycles. Without a vent, a vacuum could be created which prevents the well from pumping water. Vents consist of a pipe installed in the well casing or well cap or seal to allow for the displacement of air between the casing and the pump column. When the pump starts, air is drawn into the casing as the water level drops. Conversely, when the pump shuts off, air is expelled through the vents as the water level returns to the static water level. All vents must have screens to prevent any solid material, vermin or insects from entering the well.

3.1.8- Sources of Contamination

Because a well is a direct conduit from the surface to the groundwater below, care must be taken to prevent contamination from entering the well. It is important to place wells in high areas, out of floodways and stormwater runoff areas to prevent surface water from entering the well. Further, minimum separating distances must be kept between the well and other potential sources of contamination such as septic tanks, animal yards, buried petroleum tanks, etc. Table A in NR 812, Wis. Adm. Code, provides the required minimum separation distances. It is also important to make sure that the well cap or seal is in place and the vent is screened to prevent access by vermin and insects. Well owners should inspect these items 2-3 times a year.

3.2- PUMPS

There are two basic types of well pumps: the ***vertical turbine pump*** and the ***submersible pump***. Along with the types of wells, there are several terms that water system operators should know and understand: ***static water level***, ***pumping water level***, ***drawdown***, ***well yield and specific capacity***, and ***cone of depression***.

3.2.1- Vertical Turbine Pump

The vertical turbine pump has a motor above ground connected by a shaft to the pump below. The motor assembly is secured to the top of the well casing. The pump itself is located in the well. The pump has a series of impellers called bowl-assemblies which, when turned, push the water to the surface through a pump column (see Illustration 3-5). Each bowl-assembly provides a certain amount of lift; a sufficient number of bowl assemblies are needed to meet the lift requirements of the water column for the system being served.

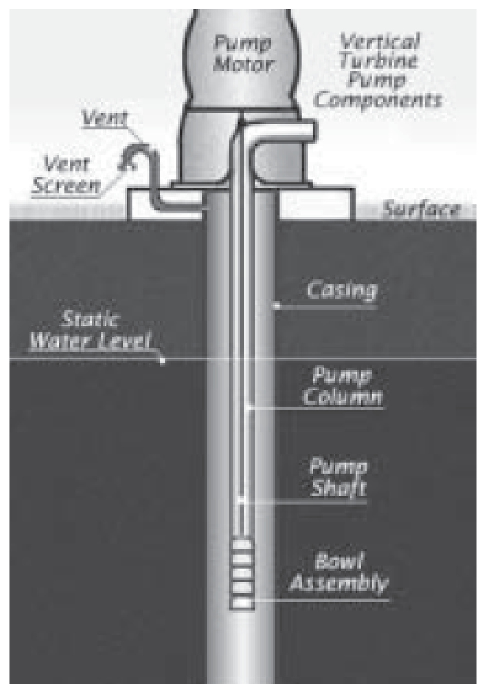


Illustration 3-5

3.2.2- Submersible Pump

The submersible pump has a motor and pump assembly in the well, attached to the bottom of the drop pipe, with an electric wire running from the surface to the motor below (see Illustration 3-6). This arrangement eliminates the need for shafts to turn the impellers.

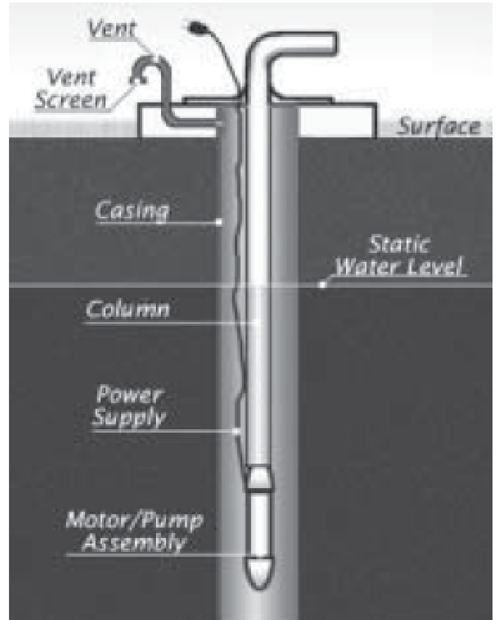


Illustration 3-6

3.2.3- Static Water Level

The top of the water level in the well while the pump is not operating is called the static water level (see Illustration 3-7). In most cases, the static water level rarely fluctuates much over time as the aquifer is recharged through the hydrologic water cycle. In some cases, due to excess pumpage from the aquifer over time, the static water level lowers as the aquifer becomes depleted.

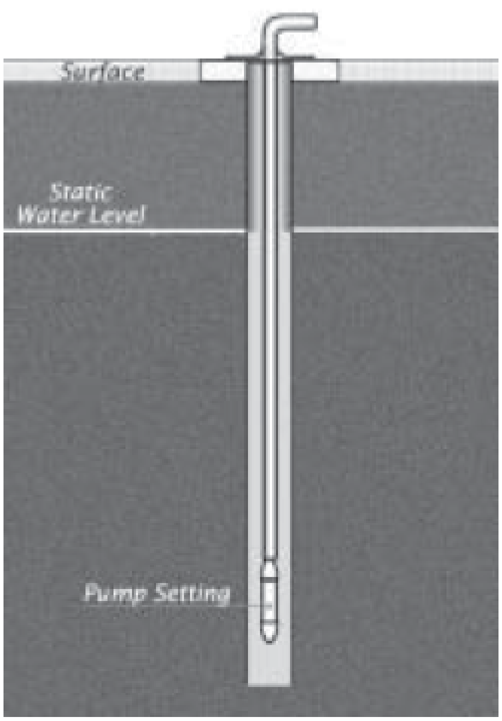


Illustration 3-7

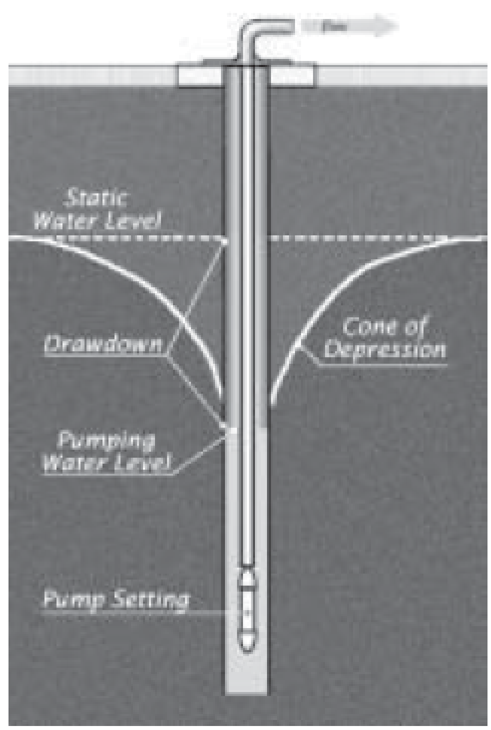


Illustration 3-8

3.2.4- Pumping Water Level

The top of the water level in the well while the pump is operating is called the pumping water level (see Illustration 3-8). This level is important because it is an indicator of the ability of the aquifer to supply water to the well.

3.2.5- Drawdown

The difference between the static water level and the pumping water level is known as the drawdown of the well (see Illustration 3-8). Drawdown is determined by the ability of the aquifer to replace the amount of water that is pumped from the well. If there is an abundance of water in an aquifer and the water can move freely to the well, the drawdown will be fairly low, typical of sand and gravel formations. Conversely, if the water cannot move through the formation quickly enough to replace the water being pumped, the drawdown can be quite high.

3.2.6- Well Yield and Specific Capacity

Well yield and specific capacity are two terms that refer to the measurement of the amount of water a well can produce. Well yield is generally expressed in gallons per minute (gpm). Specific capacity is the rate of water that discharges from a well per unit of drawdown (usually feet). It is determined by dividing the well yield by the drawdown and is usually expressed in gallons per minute per foot (gpm/ft). For example, if a well pumps 100 gpm and it has a drawdown of 30 feet, its specific capacity at that flow rate is 3.33 gpm/ft. By tracking the specific capacity of a well over time, an operator can identify well and aquifer performance problems.

3.2.7- Cone of Depression

As water is pumped from the well, a depression forms in the water table shaped like an inverted cone. This is called the cone of depression (see Illustration 3-8). If the drawdown is low, the cone of depression may only extend for a short distance away from the well. Conversely, if the drawdown is high, the cone of depression can extend for quite a ways out from the well, in some cases for hundreds of feet. The cone will continue to enlarge until the rate of groundwater flow or recharge equals the pumping rate, or sufficient leakage occurs between formations to equal the pumping rate, or the cone intercepts a surface water body (lake, stream, etc), or some combination of these occurs.

3.2.8- Air Line

In order to determine the water level in a well, many utilize an air line that runs from the pump to a gauge at the top of the well. The gauge will then show the water level in the well at any given time. In order to maintain accurate readings it’s important to replace the air line whenever pump work is completed and to inspect the air gauge condition.

3.3- CODE REQUIREMENTS

Wisconsin has strict code requirements for the placement, construction and operation of public wells. These requirements are found in chapters NR 810, 811 and 812 of the Wisconsin Administrative Code and are enforced by the DNR. Different wells have specific requirements based on their type, size and use.

3.3.1- General Requirements

Chapters NR 811 and 812, Wisconsin Administrative Code include general well construction requirements, many of which are provided below. This list is not all-inclusive.

A. DNR approval is required for the construction, reconstruction, or operation of community water system wells, high capacity wells, wastewater treatment facility wells and school wells.

B. The location of a proposed well must comply with the minimum separation distances to all contamination sources (see "Well Placement" or NR 812.08 for nontransient noncommunity systems and NR 811.16 for OTM systems).

C. Wells must be planned and constructed so that they produce an adequate supply of safe water and are adapted to the geographic and geologic conditions of the site.

D. Wells must meet DNR plumbness and alignment requirements.

E. The top of the well casing must be at least 2 feet above the regional flood level and at least 12 inches above the finished ground surface.

F. DNR approval must be obtained for any below ground style discharge for school, OTM and wastewater treatment plant wells.

G. Well casing must meet DNR thickness and material requirements.

H. New wells must be sealed or covered with an approved weather-proof and vermin-proof compression type well cap or seal.

I. Wells must be constructed by a Wisconsin-licensed well driller.

J. A written well construction report must be submitted to the DNR within 30 days of completion of the well.

3.3.2- Specific Requirements

Chapters NR 811 and 812 of the Wisconsin Administrative Code contain specific requirements for wells constructed in different formations (unconsolidated formations and bedrock), for different types of wells (radial collectors, dug wells, sandstone wells, limestone wells, gravel-packed wells, flowing wells and granite wells), and for wells serving different types of systems (school, community, noncommunity, high and low capacity, wastewater treatment plant). Familiarize yourself with these requirements and which ones apply to your situation. You must hire a licensed well driller to construct or reconstruct a well. It's always advisable to check to make sure they know, understand and follow the applicable requirements listed in chapters NR 811 and 812.

3.4- CONSTRUCTION APPLICATION

To construct a new community well, wastewater treatment facility, school well or high capacity well in Wisconsin, an application form must be filled out and submitted to the DNR for approval providing the following information:

A. The purpose of the well.

B. The name and address of the individual, corporation, partnership or sanitary district that owns the property on which the well will be constructed.

C. The name and address of the owner and/or operator of the well system.

D. A written description and map of the entire property on which the well will be constructed.

E. On the property map, the location of:

- the proposed well and any other existing wells,
- any nearby wells on other property, and
- any wetlands within 300 feet of the proposed well. Lakes, streams or rivers within 1,200 ft of the proposed well?

F. Any information on any other existing wells on the property.

G. Details on the proposed well including:

- Well depth

- Depth, material, and thickness of casing
- Type, material, and length of screen
- Geological formation
- Grouting material
- Method used to construct the well
- Name of well driller
- Location of the sampling faucet for both raw water and entry point
- Distance from the well to any contamination source
- Type and capacity of the pump, and how it's connected to the discharge piping
- Type and design of the well cap   Pump discharge-piping information including check and shut-off valves and air relief

3.5- SITING, PLACEMENT AND WELL FILLING & SEALING

3.5.1- Well Siting

Due to the numerous factors that must be taken into account when choosing a site for a new well, it is important to use every available resource at your disposal. Fortunately, information is available from a variety of sources.

Well logs from other nearby wells are a valuable source of information on the underground geology of the area. These logs are required by Wisconsin Administrative Code for any new well and must show the underground formations encountered and the depths at which they were found.

Area well drillers are a valuable source of information. They are not only familiar with local geology, but also the quantity and quality of the water from the wells they have drilled.

Local, state, and federal natural resource agencies can provide valuable information on an area's geology, known sources of contamination, and regional water quality.

Water quality sampling results from testing done at wells in the area can provide valuable information on water quality at different depths of a formation. This sampling is required for all wells serving public water systems.

3.5.2- Well Placement

A well should be located so that its surroundings can be kept in a sanitary condition. If possible, it should also be located at the highest point on the property so that it is protected from flooding and other contaminant sources. Wells should not be located downstream of any contamination source. They should be as far away from sources of contamination as possible.

Minimum separation distances for OTM and NN system wells from some common contamination sources are specified in Wisconsin Adminstrative Code, ch. NR 811 for community water systems (OTM and MC) and NR 812 for NN and TN system wells. You will want to refer to the corresponding code for a complete list of all required mininmum separation distances for your site. In special circumstances, the DNR may grant a variance to minimum separation requirements.

3.5.3- Well Filling and Sealing

In the Administrative Code, well abandonment is referred to as "***Well and Drillhole Filling and Sealing.***" Unused and improperly abandoned wells are a significant threat to groundwater and aquifers. If not properly filled and sealed, wells can directly channel contaminants into groundwater. Chapters NR 811.13 and NR 812.26 outline the requirements for permanently abandoning wells. An owner is required to permanently fill and seal a well if any of the following conditions exist:

- The well is contaminated with biological, viral, or parasitic pathogens and 3 attempts at disinfection fail to eliminate the problem.
- The well poses a hazard to health or safety, or to groundwater.
- The well does not conform to construction or location requirements.
- The well was not constructed by the owner or a licensed well driller.
- The well has been out of service for 90 days or more.
- The well has been temporarily abandoned for 5 or more years (unless an Extended Well Abandonment agreement is on file with the Department).

Review Questions for Wells

What’s the most common type of water source for water systems in Wisconsin?

Name the three most common methods of constructing a well.

What are the two most common methods of constructing a drilled well?

What is the name of the steel pipe that forms the outside of the well hole?

What is used to fill in voids around the casing of a well?

What must be installed in a well to allow air to displace the water that is pumped out?

Name the two types of well pumps and describe how they work.

What is the term for the water level in a well when the pump is not operating?

What is the term for the water level in a well when the pump is operating?

What is the term for the indentation in the water table that forms around a well as the pump is operating?

What are some of the items that must be included on a new well construction application?

Name a few of the informational resources available to someone constructing a new well.

What items should a water system operator should inspect regularly to prevent contaminants from entering a well?

How many failed attempts at disinfection to eliminate biological, viral, or parasitic pathogen contamination can be made before filling and sealing of the well is required?

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Chapter 4 - Contaminants

4.1- PRIMARY DRINKING WATER CONTAMINANTS AND MONITORING

Drinking water contaminants can be separated into two categories, acute and chronic, based on their effects to humans. Acute health effects are those that are generally more immediate, occurring within hours or days of ingesting the contaminated water. Chronic health effects are those experienced after ingesting contaminated water over a period of years. Exposure to chronic contaminants can lead to a higher risk of several types of health issues including cancer, liver and kidney problems, or problems with the nervous system.

There are several sampling and monitoring actions required to ensure accurate sample results that meet state & federal drinking water monitoring requirements. A primary consideration is the collection of each water sample from an approved monitoring site location. In many cases, the monitoring locations must be listed in a monitoring site plan that is approved by the Department of Natural Resources.

The following is a description of the contaminant sources, monitoring requirements, sampling procedures, health effects, and treatment options for the categories of primary contaminants regulated under the Safe Drinking Water Act. For details on the MCLG, MCL, sources and health effects of specific contaminants in each category, see the table at the end of this chapter.

4.2- BACTERIOLOGICAL

4.2.1-Bacteriological Contaminant Sources

Coliform bacteria are common in the environment and most are not harmful. However, the presence of coliform bacteria in drinking water is usually the result of a problem with the well, the pressure tank, the treatment system, or the pipes that distribute water, and indicates that the water may be contaminated with germs or pathogens that can cause disease.

Drinking water must be monitored for certain bacteria that could indicate that the system is vulnerable to pathogens (disease-causing microbes). Many different pathogens may be present in water. It is not practical to test for them individually. Instead, water suppliers monitor for ***indicator organism***s. The indicator organisms used for monitoring drinking water are total coliforms, and *Escherichia coli* (*E. coli*). They are usually not found in groundwater. The presence of total coliform bacteria indicates that the water may be contaminated. If *E. coli* are detected, the water may be contaminated with human or animal wastes (fecal matter).

4.2.2- Bacteriological Contamination Health Effects

The presence of disease-causing bacteria in water can cause symptoms such as nausea, cramps, diarrhea or headaches. For most people, these effects are short-term as their bodies can fight off microbes much the same way as they fight off germs. However, they can be dangerous or even deadly to infants, elderly, and those with weakened immune systems.

4.2.3- Bacteriological Monitoring Requirements

Public water systems must sample for bacteria in their drinking water monthly, quarterly, or annually depending upon system size, population served, system type and sample history.

4.2.4- Bacteriological Sampling Procedures

As you'll see in the following instructions, the basic steps for preparing to take a bacteriological sample are known as the two "F"s, ***Flame and Flush***. This is a simple way to remember the actions to take prior to collecting a sample.

1. Sampling sites must be DNR approved locations in the distribution system. Use solid metal faucets (try to avoid plastic inserts) if possible. If you don't have metal faucets, seriously consider having them installed. Avoid restrooms or any other sites with higher-than-normal chance of contamination if possible. If using a swivel faucet, do not adjust the swivel position prior to flaming the faucet. Do not sample from a dripping or leaking faucet.

   If shipping or mailing samples, determine when the package leaves the post office or shipping center and collect samples just prior to shipping or mailing. **Samples must be analyzed within 30 hours of collection.** Plan to ship or **mail early in the week** and guarantee next day delivery. Avoid Thursdays, Fridays, weekends and holidays. Plan sampling early in sample period (i.e. early in the month or quarter) to make sure enough time is available for resampling if your sample is not tested within 30 hours of sample collection or there are errors or lost samples, so that the results and reports are submitted to DNR before the sampling deadline.

2. Without opening it, inspect the sample bottle. If the bottle is damaged in any way or the cap is not fastened securely, discard the bottle and choose another one. Make sure the bottle has been provided by a Wisconsin certified lab and is specifically prepared for bacteriological samples. If your system adds chlorine for disinfection, make sure the bottle contains a neutralizing agent such as ***sodium thiosulfate***. It is OK to use a sample bottle containing sodium thiosulfate even if you do not add chlorine to your water system.

3. Write the name of your facility, date, time and site ID on the sample bottle label. This is much easier to do before you collect the sample than afterward.

4. Remove any attachments that may be connected to the faucet including any aerator/screen assembly and gasket.

5. Sterilize the tap or faucet using a propane or butane torch. Hold the flame beneath the opening for 20 seconds, moving the flame continuously to prevent damage. The purpose of flaming is kill any bacteria on the faucet that may otherwise contaminate the sample.

6. Turn on the water, using only the cold water. Allow the water to run approximately 5-6 minutes. The purpose is to flush out the line to get a representative sample of water in the distribution system.

7. Reduce the flow to a medium stream. Remove the cap from bottle without touching the inside of the cap or bottle. Hold onto the cap and bottle with your fingers away from the inside edges and away from splashing water. DO NOT set the cap down. DO NOT rinse out the bottle.

8. Without allowing the bottle to touch the faucet, hold the bottle under flow until water is just below the bottle threads at the top. Immediately replace the cap securely. If supplied with a plastic bag, place the filled bottle in the bag and close the bag.

4.2.5- Bacteriological Sample and Delivery Requirements

Fill out the lab analysis form that was included with the bottle or provided by the DNR. Make sure the system name, system type (OC or NN), PWS ID number, county and owner/operator contact information are correct. If not, make the necessary corrections. Complete Section II "Sample Information" including the sample type, name of sampler, address where sample was collected, monitoring Site ID, description of sample faucet, whether or not the water is chlorinated, and if so, the field results for free chlorine residual at sample location. Make sure you also include collection date and time. Place the sample and completed form in the package supplied and deliver it to the post office, shipping center or lab. Bacteriological samples must be analyzed **within 30 hours** of collection. Check with your post office or shipping courier for the best and fastest way to deliver the sample or use a different carrier to meet the 30-hour requirement.

4.2.6- Bacteriological Follow-Up Sampling

If any sample is total coliform positive (total coliform present), the laboratory must then test the sample for *E. coli* bacteria, and the system owner or operator must report the results of both tests to the DNR within 24 hours. **Follow up sampling is <u>required</u> after**

any total coliform, or *E. coli* positive compliance sample. Follow up samples must be collected within 24 hours after being notified of the original positive sample.

Collect samples from distribution system sites listed in the DNR approved monitoring site plan. If you do not have a DNR approved monitoring site plan, contact your DNR representative to discuss appropriate sampling locations.

Take follow-up samples after a total coliform positive result within 24 hours. The follow-up samples include one check sample, two repeat samples and triggered source water samples from all of the wells that were in service when the initial positive distribution sample was collected. The check sample is collected from the same location as the original positive sample. Two repeat samples need to be collected from approved sample site locations. If your system has only one sample location, collect all of your repeat samples at the same location. In some situations, one of these repeat samples may be used to complete the requirements of a Triggered Source Water sample. Triggered Source Water samples are collected from source water sample taps. It is best to work with your DNR representative to confirm the sampling locations for your water system. The results of the check and repeat samples will determine what additional steps are needed. Report the results to the DNR as soon as they are available to determine the next necessary actions.

If you are required to monitor for coliform less frequently than monthly, you will be required to collect 3 additional routine follow-up samples during the next calendar month to confirm that your water system is free of total coliforms. Collect these samples at different times during the month; if this is not possible, collect all samples on the same day. These samples are to be collected from any approved locations in the distribution system.

4.2.7- Bacteriological Reporting Requirements

The water system owner or operator must report to the DNR within 24 hours any failure to comply with bacteriological MCL, monitoring requirements, or treatment techniques.

The DNR will accept analytical data only from Safe Drinking Water Act (SDWA) certified labs. In addition, the DNR will accept only results obtained by an enzymatic substrate test method for bacteriological compliance monitoring. If your lab is not currently using an enzymatic substrate method, you will need to find another Wisconsin certified lab that uses the approved method.

4.2.8A- Revised Total Coliform Rule (RTCR) Assessments

When RTCR assessment triggers (described below) occur, the PWS will be required to perform investigations, "assessments," to identify the possible presence of sanitary defects, and potential issues with monitoring practices. Forms are available from the

DNR representative that identify the specific aspects of the system that require a thorough investigation.

Level 1 assessments are conducted at community water systems (CWS), typically by the certified operator, as soon as possible when a trigger has been exceeded. For Non-CWS, a DNR representative will conduct a Level 2 assessment (described below) in lieu of a Level 1 assessment. Triggers for Level 1 assessments include:

- Exceeding 5% total coliform-positive samples for the month for public water systems collecting 40 or more samples per month.

- Exceeding two or more total positive samples in the same month for public water systems collecting fewer than 40 samples per month, and

- Failing to take every required repeat sample after a routine single total coliform-positive sample.

Results of the assessment are reported using Form 3300-311 (Community Water Systems Level 1 Self-Assessment). The PWS has 30 days to submit a completed form to the DNR after notification to complete the assessment. It will include sanitary defects identified, corrective actions completed, and a proposed time-table to complete any remaining corrective actions, subject to approval by the DNR. The DNR representative will work with the water system to ensure that the cause for the level 1 trigger has been identified and that the corrective actions will fix the problem.

Level 2 assessments are conducted at CWS and Non-CWS, typically by DNR staff, when the following triggers occur:

- An E Coli MCL violation as described in NR 809.30(1)

- A second Level 1 trigger occurs within 12 months of the previous Level 1 trigger, and

- For PWS approved for annual monitoring, a Level 1 trigger occurring in two consecutive years.

Results are reported using Form 3300-312 (Community Public Water Systems Level 2 Assessment) or Form 3300-313 (Public Non-Community Level 2 Assessment Response to Bacterial Contamination). The same reporting timeline applies for Level 2 assessments as previously described for Level 1 assessments.

Any requests for changes to the corrective action timeline will be coordinated between the PWS and the DNR (for approval). Similarly, any corrections should be documented and provided to the DNR as they are completed.

4.2.8- Bacteriological Corrective Action Options

If your system has long-term or reoccurring bacteriological problems, it is important to establish the source of the problem. Collect raw water coliform bacteria samples from the well to determine if this is the source of the contamination. If the well is the contamination source, then bailing, purging, or jetting to remove sediment or debris from the well followed by shock chlorination and flushing of the system may correct the problem. Alternatively, the well and distribution system can be treated with biofilm treatment chemicals. Use of this option requires prior approval from DNR. If these treatment options do not correct the problem, reconstruction of the existing well or installation of a replacement well may offer a long-term solution. If a reconstructed or replacement well is not an option, the DNR may allow installation of the following approved types of treatment:

- Continuous Chlorination
- Ultra-Violet (UV) Disinfection
- Continuous Ozonation

The use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering treatment for your system.

4.3- NITRATE

4.3.1- Nitrate Contaminant Sources

The most common sources of nitrate in drinking water are fertilizers, septic tanks, sewage, and decomposition of organic materials. Nitrate levels in groundwater may fluctuate over time depending on the source of the nitrate.

4.3.2- Nitrate Health Effects

Nitrate is an acute contaminant. Sensitive populations are susceptible to more immediate adverse health effects. Water containing high levels of nitrate should never be fed to an infant under 6 months old. All infants under 6 months of age are at risk of nitrate poisoning. Premature babies and babies with other health problems have an increased susceptibility to poisoning from nitrate-contaminated drinking water. In young infants, nitrate can reduce the blood's ability to carry oxygen and cause a condition that doctors call methemoglobinemia or “***blue baby syndrome***” because the skin appears blue-gray or lavender in color. This color change is caused by a lack of oxygen in the blood. Infants suffering from "blue baby syndrome" need immediate medical attention because the condition can lead to coma and death if not treated promptly. Women who are or may become pregnant should not drink water with high nitrate. Other adults and children older than six months may occasionally drink the tap water, however, if you have specific health concerns, you may consider consultation with your doctor. People of all ages are urged to avoid long-term consumption of high nitrate contaminated drinking water because it is linked to several chronic diseases, according to Wisconsin Division of Public Health.

4.3.3- Nitrate Monitoring Requirements

Public water systems must sample for nitrate in their drinking water annually or as determined necessary by the DNR. Sampling supplies may be obtained by contracting with a certified lab.

4.3.4- Nitrate Sampling Procedures

Sampling procedures for nitrate are similar to bacteriological samples, except that sterilizing the faucet is not necessary and the sample is collected at an **entry point** to the water system rather than in the distribution system. An ***entry point*** is a location in the water system after treatment or chemical addition (if any) but before the distribution system.

4.3.5- Nitrate Sample and Delivery Requirements

Nitrate samples must be packed with ice immediately after the sample is collected. Place the sample in a plastic bag filled ¾ full with ice. Fill out Section II of the lab analysis form. If using alternative preservation methods make sure to follow directions provided by the lab. The lab form should be placed in a separate plastic bag to keep it dry, and it should be included in the mailing container with the sample and ice.

Nitrate samples must be **analyzed within 48 hours** of collection unless preservatives are added to the sample bottle. Follow the sample collection and preservation instructions provided by your lab. Check with your post office or shipping courier for the best and fastest way to deliver the samples to the lab or use a different carrier to meet the necessary time requirements.

4.3.6- Nitrate Follow-Up Sampling

When an initial nitrate result indicates that the **MCL is exceeded** (10 mg/L or 10 ppm), the water supplier must notify the DNR and collect a ***confirmation sample*** within 24 hours of being notified of the original analytical result. Compliance with the nitrate MCL will be based on the average of the initial and confirmation sample results.

If the water supplier cannot collect the confirmation sample within 24 hours of receiving the initial nitrate result, the operator must immediately provide a Tier 1 Public Notice to notify all consumers served by the system that the water exceeds the MCL for nitrate. Operators using this option **must** collect a confirmation sample and have it analyzed within 2 weeks of notification of the original nitrate sample result.

4.3.7- Nitrate Reporting Requirements

Upon receipt of the analytical results from the lab, check to make sure that the required testing was done (check the back of the lab form). Retain a copy of the results for your records. All certified labs must submit results electronically to the DNR. The results must be submitted within:

- The first ten days following the month in which the analysis is completed, **or**
- The first ten days following the end of the compliance period in which the monitoring was required**.**

  Example: You are required to monitor for nitrate in the first quarter of the calendar year (January - March). You collect your sample on January 2 and receive the results on January 30. You must report the results to DNR no later than February 10. However, if you collect your sample on March 1 and receive the results on March 20, you must report the results to DNR no later than April 10.

It is the responsibility of the water system owner/operator to;

- Make sure that the results were reported in the correct time frame.
- Report all MCL violations, monitoring and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the violation.

4.3.8- Nitrate Corrective Action Options

When a water system source becomes contaminated with nitrate above the MCL, the water system owner will be required to bring the system back into compliance. Any corrective action needs to be approved by the DNR. The water system owner should work with their contractor\consultant, if any, and DNR representative to complete a corrective action options evaluation. Generally, the primary option is to reconstruct the existing well or drill a new well into a deeper, protected aquifer. Check with the DNR to make sure you are aware if any type of approval is required before drilling a new well or reconstructing an existing well on site. When an alternative aquifer is not available, the DNR may allow installation of approved treatment types:

- Ion Exchange
- Reverse Osmosis

The use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering treatment for your system.

4.4- INORGANICS (IOC)

4.4.1- IOC Sources

The presence of inorganic chemicals in drinking water may be caused by naturally occurring processes such as the dissolution of minerals in soil, rock, and sediment. The presence of inorganic chemicals in drinking water may also be a result of agricultural, industrial, and mining activities, and other human practices. IOCs regulated under the Safe Drinking Water Act include arsenic, nitrate, asbestos, chromium, and mercury, among others.

4.4.2- IOC Contamination Health Effects

The potential health effects associated with the presence of inorganic contaminants in drinking water depend on the contaminant and the levels found. The chronic effects of drinking water contaminated with inorganic contaminants over time may include increased risk of cancer, damage to the liver, kidney, and circulatory systems, or damage to the intestines or central nervous system.

4.4.3- IOC Monitoring Requirements

Non-community public water systems are required to sample for most inorganic contaminants during the initial year of service and then routinely every 3 years. An increased routine monitoring frequency may be implemented based on susceptibility or detection of certain IOC contaminants. Sampling supplies may be obtained by contracting with a Wisconsin certified lab. The back of the lab form shows exactly which samples are required.

4.4.4- IOC Sampling Procedures

Prior to collecting any samples, read and follow all sampling instructions provided by the lab. IOC samples are collected at an ***entry point*** to the water system (first sampling point after all treatment, including water softeners, but before the distribution system). If the entry point to be sampled is served by more than one well (a combined entry point), make sure all of the wells are running when you collect your IOC sample. IOC samples should be collected early in the week to ensure receipt by the lab under required shipping, preservation, and holding times (Monday, Tuesday or Wednesday).

1. If the sample faucet has an aerator, remove it.

2. Run water until cold, or for small systems, until the well pump goes on.

3. Write the system name or public water system identification number (PWS ID#) and the entry point number on the cap or bottle label.

4. Collect samples in appropriate bottles. Immediately preserve samples with appropriate preservatives according to the instructions provided by the lab, if needed.

5. Complete Section II of the lab and place it in a sealed plastic bag and put it in the mailing container.

6. Follow the instructions provided by the lab for shipping the samples.

4.4.5- IOC Sample Reporting Requirements

Upon receipt of the analytical results from the lab, check to make sure that the required testing was done (check the back of the lab form). Retain a copy of the results for your records. All certified labs must submit results electronically to the DNR as per Wis. Admin. Code. The results must be submitted within:

- The first ten days following the month in which the analysis is completed,

  OR

  The first ten days following the end of the compliance period in which the monitoring was required**.**

- Report all MCL exceedances, monitoring and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the exceedance or violation.

4.4.6- IOC Corrective Action Options

When a water system source becomes contaminated with an inorganic compound above a MCL, the water system owner will be required to bring the system back into compliance. The water system owner should work with their contractor\consultant (if they have one) and DNR representative to complete a corrective action options evaluation. Generally, the preferred option is to reconstruct the existing well or drill a new well. Check with the DNR to make sure you are aware if any type of approval is required before drilling a new well or reconstructing an existing well on site. When an alternative aquifer is not available, the DNR may allow installation of approved types of treatment including:

- Reverse Osmosis
- Ion Exchange
- Lime Softening
- Filtration

The use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering treatment for your system.

<u>4.5- LEAD AND COPPER</u>

4.5.1- Lead and Copper Sources

Although lead and copper are both inorganic contaminants that occur naturally in the environment, the most common source in drinking water is in service lines, household piping, and plumbing fixtures.

4.5.2- Lead and Copper Health Effects

Elevated levels of lead in the human body can cause serious damage to the brain, kidneys, nervous system, and red blood cells. Those at highest risk are young children and pregnant women.

Although copper is an essential nutrient required by the body, elevated levels can cause stomach and intestinal distress, liver and kidney damage and anemia. Also, persons with Wilson’s disease may be more sensitive to the effects of copper contamination.

4.5.3- Lead and Copper Monitoring Requirements

Public water systems are required to sample for lead and copper every 6 months, annually, or triennially depending on which stage of the Lead and Copper Rule a system has completed. Systems need to check their monitoring schedules regularly to know when lead and copper samples need to be collected. Compliance monitoring for lead and copper requires sample collection from the distribution portion of a public water supply system. Lead and copper samples must be collected from the same approved locations during each sampling event. Systems not exceeding lead and copper action levels for two consecutive six-month compliance periods may be eligible to reduce their monitoring frequency to annually. If results remain below action levels for 3 years, monitoring may be further reduced to once every 3 years if appropriate monitoring and compliance criteria are met.

Develop a Sampling Plan

Public water systems must develop a Monitoring Site Plan identifying lead and copper sampling sites that meet Lead and Copper Rule (Rule) criteria. Monitoring Site Plans must be approved by regional DNR Representatives prior to sampling. Sampling sites must be selected to evaluate where lead and/or copper may be leaching into drinking water. Typically, source water does not contribute to lead and copper in drinking water; rather, these types of contaminants are found in drinking water in association with distribution system infrastructure.

The interaction of water and different treatment types with distribution system infrastructure such as services lines and premise plumbing can cause lead and copper to leach into drinking water. A tiering system has been established in the Rule to help identify which type of services lines and/or plumbing materials have the greatest capacity to leach lead and/or copper (see table *Sample Site Tier Criteria*). Additional consideration must also be given to water use and fixture type, when considering potential lead and copper sources.

Evaluate the following criteria when selecting sampling sites for lead and copper monitoring:

1. Select sites in accordance with Rule Tier Criteria (next page).

2. Identify Tier 1 sites first; if there are not enough Tier 1 sites to complete the sampling requirement, then Tier 2 sites can be utilized (then Tier, 3, then Tier Exceptional).

3. Select cold-water interior taps where water is used for human consumption.

4. Select taps that are used on a regular basis.

5. Do not use taps downstream of softening or filtration devices.

4.5.4- Lead and Copper Sampling Procedures

Samples must be ***first-draw*** after water has been motion-less in the plumbing for a **minimum of 6 hours**. Lead and Copper samples should be collected as follows:

1. Samples must be collected from cold, untreated water taps in the kitchen or bathroom of residential buildings. Non-residential building samples must be collected from cold-water interior taps where water is typically drawn for human consumption. Taps connected to a softener or other point-of-use-devices are not recommended. Do not remove aerators or other attachments before collecting lead and copper samples.

2. Collect compliance samples in 1-liter polyethylene bottles only. A wide-mouth sample bottle is recommended. Preserve the samples according to the instructions provided by the lab.

3. When preparing to send samples to the laboratory for analysis, make sure that all sections of the lead and copper sample form are completed and that the form is included with your lab sample. This includes clearly noting the date and time the sample was collected, the sample ID, the address, and the location (e.g. the second floor) and tap description (e.g. bathroom cold water tap) where the sample was collected.

4. **SAMPLE EARLY IN THE MONITORING PERIOD.** If a lead and/or copper exceedance occurs, additional sampling requirements must be completed in the same monitoring period. If the monitoring period has ended before follow-up sampling has occurred, a violation will be assigned.

5. Place the sample bottles in a sealed plastic bag and put them into the mailing container.

SAMPLING SITE TIER CRITERIA	
OTM Systems	**Non-Transient, Non-Community Systems**
TIER 1: Single family residences with: • Lead service lines; or • Lead goosenecks; or • Copper plumbing with lead solder constructed between January 1983 and September 1984; or • Lead plumbing within the home	**TIER 1: Sites where structures contain:** • Lead service lines; or • Lead goose necks; or • Copper plumbing with lead solder constructed between January 1983 and September 1984; or • Lead plumbing
TIER 2: Multi-family residences or other buildings with: • Lead service lines; or • Lead goose necks; or • Copper plumbing with lead solder constructed between January 1983 and September 1984; or • Lead plumbing within the structure	**TIER 2: Sites where structures contain:** • Copper plumbing with lead solder constructed before January 1983 *If you do not have enough Tier 1 and Tier 2 sites, use sites where water is typically drawn for drinking or cooking.
TIER 3: Single family residences with: • Copper plumbing with lead solder constructed before January 1983	**Not Applicable to NTNCWS**
EXCEPTIONAL: Sites where plumbing materials are representative of what is commonly found at other sites served by the water system, including: • Copper plumbing with lead solder constructed after 1984 • Tier 1, 2, or 3 sites with whole house water softeners or filters	**EXCEPTIONAL: Sites where plumbing materials are representative of what is commonly found at other sites served by the water system, including:** • Copper plumbing with lead solder constructed after 1984 • Tier 1, 2, or 3 sites with whole system water softeners or filters
DO NOT use Exceptional sites unless they are the only sites available for testing.	

4.5.5- Lead and Copper Sample Reporting Requirements

Upon receipt of the analytical results from the lab, check to make sure that the required testing was done. Retain a copy of the results for your records. All certified labs must submit results electronically to the DNR per Wis. Admin. Code. The results must be submitted within:

- The first ten days following the month in which the analysis is completed,

  OR

- The first ten days following the end of the compliance period in which the monitoring was required.

It is the responsibility of the water system owner/operator to make sure that the results were reported in the correct time frame.

- Report all action level (AL) exceedances, monitoring and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the exceedance.

- Notify affected consumers of lead and copper sampling results where sample results exceed the action level **within 24 hours** of receipt of the laboratory report.

- Prepare a *Lead Consumer Notification* informing consumers of lead and copper sampling results within 30 days of receipt of laboratory reports.

- Certify to the Department that consumers were notified within the required time frame. The *Certification of Consumer Notification* is due to the Department 90-days after the end of the applicable monitoring period; contact Regional DNR representatives for assistance with certification deadlines.

4.5.6- Lead and Copper Action Level Exceedances

The Lead and Copper Rule is different from other SDWA rules in that lead and copper values are evaluated at an Action Level rather than a maximum contaminant level. Exceeding an Action Level requires follow-up actions by the PWS.

When lead concentrations exceed the lead action level of 15 ppb (or 0.015 mg/l) or copper concentrations exceed the copper action level of 1.3 ppm (or 1.3 mg/l) in more than 10% of customer taps sampled (i.e. Action Level Exceedances or ALEs), the system must undertake a number of additional actions to evaluate the source of lead and/or copper in the system and identify corrective actions to reduce lead and/or copper in drinking water. Additionally, the system must also inform the public about steps they should take to protect their health.

Follow-up actions that systems are required to complete following an ALE include:

1. Conduct water quality parameter monitoring at entry points and within the distribution system; water quality data will help to evaluate the cause of the ALE.

2. Collect source water lead and copper samples from the well to evaluate lead and copper levels in the source water.

3. Complete the Department's *Corrosion Control Treatment Recommendation Packet* in order to identify optimal corrosion control treatment or other corrective actions for the public water system to reduce lead and copper in drinking water.

4. Deliver Public Education materials to consumers continuously, until the system has completed one 6-month round of sampling where sample results do not result in an ALE.

5. Sample the tap water of any customer who requests it. Any lead and copper sample collected from a site not on the approved monitoring site plan is considered to be an investigative sample.

4.5.7- Lead and Copper Treatment Options

Lead and copper differ from most other contaminants in that they are not usually found in the source water. These inorganic contaminants enter drinking water when water comes in contact with lead or copper components in the distribution system. Therefore, treatment methods to reduce lead or copper can include making adjustments to source water quality to make it less aggressive (e.g. using corrosion control inhibitors to create a protective film to minimize water interactions between water and lead and copper components). USEPA has identified several treatment approaches for corrosion control including:

1. pH adjustment

2. Addition of calcium

3. Addition of inhibitors (phosphates or silicates)

Some of the treatment options implemented for corrosion control include:

1. Injection of blended phosphates, polyphosphates, or orthophosphates

2. Injection of sodium silicates

3. Injection of sodium hydroxide

4. Lime contactors

5. Addition of soda ash

6. A combination of the above treatments

The use of any chemical addition, treatment device, or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Contact your DNR representative for details if you are considering treatment for your system.

It is important to note that, in some cases, a small noncommunity system may be able to reduce lead and copper levels by replacing all plumbing or fixtures that may contribute to elevated levels in the distribution system. This would eliminate the need for constant corrosion control treatment.

4.6- VOLATILE ORGANICS (VOC)

4.6.1- VOC Sources

The presence of volatile organic contaminants (VOCs) in drinking water is primarily due to discharges at locations where VOCs are used or manufactured, including commercial and industrial sites and other sites where improper disposal of VOC-containing products has occurred. VOCs are used in numerous types of products including fuels, solvents, hydraulic fluids, and dry-cleaning agents.

4.6.2- VOC Health Effects

The potential health effects associated with volatile organic contaminants in drinking water vary depending on the contaminant and the level found. Usually VOCs identified in groundwater and drinking water are not acutely toxic but instead have compounding health effects through chronic (long-term) exposure. Health effects include the risk of cancer, anemia, liver or kidney damage, or damage to the nervous and circulatory systems.

4.6.3- VOC Monitoring Requirements

Public water systems are required to sample for VOCs quarterly for the first year and annually for 3 subsequent years. Thereafter, VOC monitoring may be reduced to once every 3 years if the historical analytical results indicate no detection of VOCs. A VOC monitoring waiver (waived to every 6 years) may also be evaluated based on analytical results, well construction, susceptibility to potential contaminant sources, and VOC analytical history. **System owners are responsible for submitting a monitoring assessment every three years to be eligible for reduced monitoring and waiver evaluations.** If VOCs are detected in the drinking water, increased monitoring is required. Sampling supplies may be obtained by contracting with a Wisconsin certified lab. The back of the lab form identifies which VOCs are required for analysis.

4.6.4- VOC Sampling Procedures

VOC samples are taken at the ***entry point*** to the water system, which means the sample is taken after all treatment (including water softeners) and before the distribution system. Prior to sampling, evaluate the area around the sample tap for possible VOC sources that may be in the room where the sample will be collected. A loosely-sealed or open gas can in a pump house could give off VOCs that could be detected in your sample. Check for cleaners, fresh paint, solvents, degreasers, or chemical spills which could also taint a sample. Some other products that could possibly contaminate a sample are perfume, cosmetics, skin-applied pharmaceuticals, sun tan lotion, automotive products, crystalline bathroom/urinal deodorizers, and plumbing contaminants. If odors from any of these are present, vent the area prior to sampling. It is recommended not to store any products containing VOCs near any wells or sample taps.

1. If a sampling faucet has an aerator, remove it. Run the water until cold. Reduce flow to a slow, thin stream.

2. Fill out the sample bottle labels before collecting the samples. Use caution when filling out labels. Certain permanent markers may have VOCs in the ink.

3. Remove the cap from the sample vial, making sure not to lose the Teflon liner. If the liner falls out, replace it in the cap, smooth-Teflon side down, and flush under running water for 30 seconds.

4. If required by the lab, add the provided preservative to the bottle. Water systems that chlorinate may also be required to add ascorbic acid to the sample bottle.

5. To minimize the formation of bubbles, tip the vial at a slight angle and allow a slow, steady stream of water to run down the inner wall of the vial. Fill vial with a minimum of splashing until you form a positive (convex) meniscus at the brim. Do not overflow excessively.

6. Replace the cap by gently setting it on the water meniscus, making sure that the white, smooth side of the liner faces down. Tighten firmly, but do not over tighten-- the vial can easily be broken.

7. Turn the vial over and check for air bubbles. If there is a bubble larger than the size of a small pea, add more water.

8. Complete Section II of the lab form and place it in a sealed plastic bag and put it in the mailing container. Samples must be shipped on ice according to the lab instructions.

4.6.5- VOC Reporting Requirements

Upon receipt of the analytical results from the lab, check to make sure all required analyte (parameter) testing was done. Retain a copy of the results for your records. All certified labs must submit results electronically to the DNR. The results must be submitted within:

- The first ten days following the month in which the analysis is completed,

  OR

- The first ten days following the end of the compliance period in which the monitoring was required**.**

It is the responsibility of the water system owner/operator to;

- Make sure that all results are reported in the correct time frame.

- Report all MCL violations, monitoring, and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the violation.

4.6.6- VOC Corrective Action Options

When a water system source becomes contaminated with a VOC above the corresponding MCL, the water system owner will be required to bring the system back into compliance. The water system owner should work with their contractor\consultant (if they have one) and DNR representative to complete a corrective action options evaluation. Check with the DNR to make sure you are aware if any type of approval is required before drilling a new well or reconstructing an existing well on-site. Generally, the primary option is to reconstruct the existing well or drill a new well. When an alternative aquifer is not available, the DNR may allow installation of certain types of treatment with approval including:

- Granular Activated Carbon
- Air-Stripping

The use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering treatment for your system.

4.7- SYNTHETIC ORGANICS (SOC)

4.7.1- SOC Sources

Synthetic organic contaminants (SOCs) are semi-volatile organic contaminants commonly found in plasticizers, herbicides, and pesticides. In Wisconsin, SOCs most commonly detected in drinking water systems are pesticides and herbicides or their breakdown products. These contaminants are commonly associated with pesticide storage and handling facilities, but they may also be associated with agricultural applications of herbicides and lawn-treatment chemicals in urban settings. The presence of SOCs in drinking water is usually due to the runoff or infiltration of the contaminants into the groundwater.

4.7.2- SOC Health Effects

The potential health effects associated with synthetic organic contaminants in drinking water vary depending on the contaminant present and the level found. Usually SOCs identified in groundwater and drinking water are not acutely toxic, but instead have compounding health effects through chronic (long-term) exposure. Health effects include the risk of cancer, anemia, damage to the eyes, liver, kidneys, and spleen, and problems with the cardiovascular, nervous, and reproductive systems.

4.7.3- SOC Monitoring Requirements

OTM and NN public water systems are required to complete an initial sample for SOCs. A SOC monitoring waiver (waived to every 6 years) may also be evaluated based on well construction, susceptibility to potential contaminant sources, and SOC analytical history. **System owners are responsible for submitting a monitoring assessment to be eligible for reduced monitoring and waiver evaluations.** Monitoring assessments must be re-submitted to the WDNR every three years to evaluate eligibility of reduced monitoring or waiver eligibility. If there are no SOC detections in the initial sample results, a system may be eligible for a waiver after the submittal of a monitoring assessment, pending eligibility determination. Sampling supplies may be obtained by contracting with a Wisconsin certified lab. The back of the lab form identifies which SOCs are required for analysis.

4.7.4- SOC Sampling Procedures

SOCs are taken at an ***entry point*** to the water system, which means the samples are taken after all treatment (including water softeners) but before the distribution system.

1. Read and follow the sampling and shipping instructions provided by the Wisconsin certified lab that you have chosen to do the testing.

2. Fill out the sample bottle labels before collecting the samples. Do not use plastic containers, funnels, or hoses to collect the sample as they may inadvertently contaminate the sample.

3. Run the water until cold.

4. Fill 1-liter amber bottles. If your system chlorinates its water, make sure the amber bottles contain ***sodium thiosulfate***, which dechlorinates the water. You will also need to fill 40 ml vials. These vials contain 1.2 ml of monochloroacetic acid. Do not remove the acid from the vials. If your system chlorinates its water, make sure to add sodium thiosulfate to the vials to neutralize any chlorine. The 40 ml vials should be filled with no air bubbles.

5. Complete Section II of the lab form and place it in a sealed plastic bag and put it in the mailing container. Samples must be shipped on ice according to the lab instructions.

4.7.5- SOC Sample Reporting Requirements

Upon receipt of the analytical results from the lab, check to make sure all required testing was done. Retain a copy of the results for your records. All certified labs must submit results electronically to the DNR. The results must be submitted within:

- The first ten days following the month when the analysis is completed,

  OR

- The first ten days following the end of the compliance period in which the monitoring was required.

It is the responsibility of the water system owner/operator to;

- Make sure that the results were reported in the correct time frame.

- Report all MCL violations, monitoring and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the violation.

4.7.6- SOC Corrective Action Options

When a water system source becomes contaminated with a SOC above the corresponding MCL, the water system owner will be required to bring the system back into compliance. Generally, the primary option is to reconstruct the existing well or drill a new well. The water system owner should work with their contractor\consultant (if they have one) and DNR representative to complete a corrective action options evaluation. Check with the DNR to make sure you are aware if any type of approval is required before drilling a new well or reconstructing an existing well on site. When an alternative aquifer is not available, the DNR may allow installation of certain types of treatment with approval including:

- Granular Activated Carbon

The use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering treatment for your system.

4.8- RADIONUCLIDES

4.8.1- Radionuclide Sources

The presence of radioactive elements in drinking water is primarily due to the dissolution of minerals that are naturally occurring in the environment.

4.8.2- Radionuclide Health Effects

The potential health effect typically associated with elevated levels of radioactive contaminants in drinking water includes an increased risk of cancer.

4.8.3- Radionuclide Monitoring Requirements

Only community water systems are required to monitor for radionuclides. Supplies for the collection of drinking water samples may be obtained by contracting with a certified lab. The back of the lab form shows exactly which samples are required.

4.8.4- Radionuclide Sampling Procedures

Community public water systems may be required to analyze for several types of radionuclide contaminants including: gross alpha, combined radium (radium 226 and 228), radon, and uranium. The procedures for collecting these samples follows.

4.8.5- Gross Alpha Grab Sample

Gross alpha grab samples must be collected from an ***entry point*** to the water system, which is after storage and treatment but before the distribution system. A new 1-liter polyethylene bottle, unpreserved is required.

1. Run water until cold.
2. Print the system name (or field number if desired) on cap and bottle label.
3. Fill the sample bottle and securely tighten the cap
4. Complete Section II of the lab form.
5. Place the lab form and sample bottles in the mailing container and ship the samples according to the instructions provided by the lab.

4.8.7- Combined Radium Grab (RG) Sampling

Radium grab and quarterly samples must be collected from an entry point, after storage and treatment but before the distribution system. The bottle required is a 1-gallon cubitainer.

1. Run water until cold.
2. Fill the container.
3. Add one ampule of concentrated nitric acid preservative.
4. Complete Section II of the lab form.

5. Place the lab form and sample bottle in the mailing container and ship the sample according to the instructions provided by the lab.

4.8.8- Radon Sampling Procedures

For best results, radon samples should be collected after the well has pumped for a period long enough to allow collection of a representative sample of freshwater from the geologic formation. For small systems, the samples should be collected after the pump has cycled several times. The sample should be collected as close to the source as possible, prior to any treatment or storage, and preferably from the well pump discharge pipe-sampling tap. The radon test kit contains a 15-ml glass vial with a two-piece Teflon-lined cap. You will also need a bowl or other container that is at least 3 inches deep.

1. If sample faucet has an aerator, remove it.

2. Run water until cold.

3. Remove the cap from the sample vial, making sure that the liner does not fall out. If the liner does fall out, replace it in the cap so the white Teflon-coated side of the liner is not visible when the vial is capped.

4. Place the bowl directly under the faucet and fill, being careful to keep the spigot opening under water after the bowl begins to fill.

5. Fill the bowl to the point of overflowing. Continue adding water for about a minute with the opening of the faucet still below the water level.

6. Submerge the vial in the bowl, open-side up, until it fills. At this point, set the bowl down and put the cap in the water, open-end up. While still under water, replace the cap on the vial. Tighten firmly, but do not over-tighten.

7. Lift the closed vial out of the water. Turn the vial upside down and check closely for air bubbles. If there is an air bubble, empty the vial and the bowl and start again.

   NOTE: As a gas, radon prefers air to water. With even a small bubble in the vial, some of the radon leaves the water, leaving less radon in the water to measure.

8. Complete Section II of the lab form.

9. Place the vial and the lab form in the styrofoam mailer. Only the vial should be enclosed in the plastic bag provided. Secure the mailer with tape and attach the mailing label provided.

10. Ship the sample as soon as possible after the vial is filled to the lab, using the most reliable and fastest delivery possible. The sample should be received by the lab no later than 2 days after sampling. The earliest possible receipt of the sample at the lab allows the most accurate radon concentrations to be obtained. Do not let the sample freeze.

4.8.9- Uranium Sampling Procedures

Uranium samples must be collected from the facility's ***entry point***, after storage and treatment but before the distribution system. The bottle required is a 1-gallon cubitainer. If the collection kit is unassembled (not cube shaped), assemble it by placing the expanded plastic cubitainer into the cardboard mailing container. Sampling supplies may be obtained by contracting with a certified lab. The back of the lab form shows exactly which samples are required.

1. Extend the neck of the cubitainer by pulling up on the ring below the cap.

2. Collect the sample from the location specified by the DNR or run the water from an unsoftened tap for approximately one minute. Water softening removes radioactivity.

3. Collect the sample (For GRAB sample: Fill the 1-gallon cubitainer to within an inch of the top).

4.8.10- Radionuclide Sample Reporting Requirements

Upon receipt of the sample results from the lab, check to make sure that all required testing was done. Retain a copy of the results for your records. All certified labs must submit results electronically to the DNR. The results must be submitted within:

- The first ten days following the month when the analysis is completed,

  OR

- The first ten days following the end of the compliance period in which the monitoring was required**.**

It is the responsibility of the water system owner/operator to:

- Make sure that the results were reported in the correct time frame.

- Report all MCL violations, monitoring and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the violation.

4.8.11- Radionuclide Treatment Options

When a water system source becomes contaminated with a radionuclide above the corresponding MCL, the water system owner will be required to bring the system back into compliance. Generally, the primary option is to reconstruct the existing well or drill a new well. When an alternative aquifer is not available, the DNR may allow installation of certain types of treatment with approval including:

- Reverse Osmosis
- Ion Exchange
- Lime Softening

The use of any treatment device or technique requires prior approval from the DNR. Call your DNR representative for details if you are considering treatment for your system.

4.9- DISINFECTANTS & DISINFECTION BYPRODUCTS (DBPs)

4.9.1 DBP Sources

Some water systems treat their water with a chemical disinfectant in order to inactivate any microbial contaminants that may be present. While the benefits of disinfection are clear, the chemicals react with organic and inorganic matter in the water and form disinfection byproducts (DBPs), some of which pose health risks at certain concentrations.

4.9.2- DBP Health Effects

The potential health effects associated with DBP contaminants in drinking water vary depending on the contaminant present and the level found. Usually DBPs identified in groundwater and drinking water are not acutely toxic but instead have compounding health effects through chronic (long-term) exposure. Health effects include the risk of cancer, irritating effects to the eyes and nose, liver, kidneys, and problems with the nervous, and reproductive systems.

4.9.3 DBP Monitoring Requirements

Community and non-transient non-community water systems that add chemical disinfectants to the drinking water (excluding ultraviolet light) must monitor for DBPs in the distribution system at approved DNR locations. Disinfection byproduct testing monitors primarily for the total level of trihalomethanes (TTHMs) and five haloacetic acids (HAA5) in the water system. Sampling supplies may be obtained by contracting with a certified laboratory. The back of the lab form indicates which samples are required.

Generally, routine DBP monitoring frequency for non-transient non-community and community water serving less than 10,000 customers is annual. Systems serving less than 500 customers may be eligible for triennial (every 3 years), reduced monitoring. The number and type of DBP samples varies with the number of customers served by the system. If a system exceeds the MCL for either TTHM or HAA5 at a specific location while monitoring annually or less frequently than annually, the system will be required to sample dual sample sets (TTHM and HAA5) at all locations with an increase in frequency to once per quarter.

4.9.4 DBP Sampling Procedures

TTHM and HAA5 samples must be collected at monitoring locations approved by the department. System owners or operators need to work with their Department representative to determine appropriate DBP monitoring site locations. TTHM and HAA5 monitoring site selection criteria include:

TTHM – Residence time affects TTHM formation. TTHM should be monitored:

- At areas of historically high TTHM analytical results
- At distribution system dead-ends – end of a water main but not at locations after the last customer. Sampling should be representative of water that is being consumed; not stagnant water.
- With low or no residual (relative to initial disinfectant levels)
- After booster chlorination
- At locations after storage tanks
- At low water use areas

HAA5 – Residual HAA5 contaminants can form and decompose (via biodegradation) which is different from TTHM formation. Locations of the longest residence time may not always be the best or most representative location for HAA5 samples.

HAA5 should be monitored:

- At areas of historically high HAA5 analytical results
- With low or no residual (relative to initial disinfectant levels)
- After booster chlorination
- At distribution system dead ends – end of a water main but not at locations after last customer.
- At locations after storage tanks

Monitoring for both TTHM and HAA5 must be at the locations of the highest identified value for each contaminant group. If the highest-detected monitoring locations are different for TTHM and HAA5, these are called *Individual* monitoring locations. If both the highest TTHM and HAA5 location are found at the same location, this location is referred to as a *Dual* sample set. TTHMS and HAA5 monitoring must be conducted at the same time regardless of location types (Individual or Dual). Make sure to add preservative to all of the sample bottles sent to you by the lab according to the directions in the sampling kit.

You must also measure and report the residual chlorine concentration for your system, at each location where total coliform bacteria samples are collected. The residual chlorine sample should be collected and measured at the same time that you take your total coliform sample. **The use of a color wheel to measure residual chlorine levels is no longer allowed**. This measurement must now be done with a pocket colorimeter or other method that is specifically designed to measure residual chlorine. The LaMotte DC1200 or the HACH pocket colorimeter II are two instruments that can be used for this measurement. Follow the instructions provided by the manufacturer when making this measurement.

4.9.5 DBP Sample Reporting Requirements

Upon receipt of the analytical results from the lab, check to make sure all required testing was done. Retain a copy of the results for your records. Then sign and date the form and submit it to the DNR within the time frame listed below:

- The first ten days following the month when the analysis is completed,

OR

- The first ten days following the end of the compliance period in which the monitoring was required**.**

- Report all MCL violations, monitoring and reporting violations, and public notice violations to DNR **within 24 hours** of the time you become aware of the violation.

4.9.6 OEL Reports

A system on quarterly monitoring as a result of routine or increased monitoring requirements may be subject to an *operational evaluation level report* (OEL) if monitoring results indicate an increase in TTHM and HAA5 levels approaching a MCL exceedance.

An *operational evaluation level report* is required based on results of the following OEL equation:

The sum of the two previous quarters of results plus twice the current quarter divided by 4 (same equation is used for both TTHM and HAA5 individual results).

If the result of the OEL equation exceeds the respective TTHM and HAA5 MCLs, an OEL report must be completed. The purpose of the operational evaluation level report is to evaluate the system treatment and distribution operational practices, including storage tank operations, excess storage capacity, distribution system flushing, changes in sources or source water quality, and treatment changes or problems that may contribute to TTHM and HAA5 formation and what steps could be considered to minimize future exceedances.

4.10- SECONDARY CONTAMINANTS

Secondary contaminants refer to contaminants that affect the aesthetic quality of drinking water (taste, odor, color) but may not impact public health. In elevated levels, and upon receipt of complaints by consumers, the DNR may require corrective action for secondary contaminants. The following are the secondary standards, aesthetics, and treatment options for inorganic chemicals:

Contaminant	**Standard (mg/L)**	**Aesthetics**	**Treatment Options**
Aluminum	0.05 to 0.2	Discoloration of water	Ion exchange; RO
Chloride	250	Taste, odor	Ion exchange; RO
Color	15 units	Color	Ion exchange; RO
Copper	1.0	Staining	Ion exchange; RO
Corrosivity	non-corrosive	Corrosion	pH adjustment; addition of calcium or inhibitors
Fluoride	2.0	Mottling of teeth	
Foaming agents	0.5	Discoloration	Carbon filtration
Hydrogen sulfide	not detectable	Odor	Aeration
Iron	0.3	Taste, odor, color, staining	Filtration; chlorination
Manganese	0.05	Taste, odor, color, staining	Filtration; chlorination
Odor	3 (threshold odor #)	Odor	Filtration; chlorination
Silver	0.1	Discoloration of skin	Ion exchange; RO
Sulfate	250	Taste, odor	Ion exchange; RO
Total residue	500	Taste, corrosivity	RO
Zinc	5	Taste	Ion exchange; RO

4.11 MONITORING ASSESSMENTS

The Department may grant monitoring waivers (reduced monitoring requirements) to public water supply systems based on specific monitoring assessment criteria and an evaluation of historical source water monitoring results. The monitoring assessment criteria include an evaluation of contaminant use in an area and an evaluation of the water source's vulnerability to contamination. A complete assessment includes:

- Identification of a water source's proximity to potential contaminant sources;
- Analysis of local geology;
- Evaluation of well construction criteria; and
- Review of previous source water analytical results.

Monitoring waivers are based on specific monitoring schedules established by EPA's *Standardized Monitoring Framework.* The monitoring framework consists of nine-year cycles subdivided into three 3-year periods. The framework establishes monitoring schedules for specific contaminant groups including asbestos, volatile organic compounds, synthetic organic compounds, and inorganic compounds. Monitoring waivers allow public water supply systems to reduce sampling frequencies by three, six, or nine years.

Public water supply owners need to submit a monitoring waiver application to be eligible for waivers. Monitoring waivers may decease a public water system's sampling frequency for specific contaminant groups.

The objective of the monitoring assessment program is to reduce the frequency of monitoring while assuring the safety of the drinking water. As a result, monitoring waivers can provide cost savings to public water system owners. DNR estimates the average monitoring waiver cost savings per source water well to be $2,500 per monitoring period. DNR may grant monitoring waivers based on an evaluation of a completed monitoring assessment for each well in a public water supply system. No fees are charged to process and implement monitoring waivers or to evaluate information for potential reduced monitoring requirements.

Review Questions for Contaminants and Sampling Procedures

What is the catch-phrase for the steps to take before collecting a bacti sample?

Where are bacti samples collected from - an entry point or the distribution system?

What is the one procedure that is done for bacti sampling that is not done for any other type of sampling?

If a system is adding chlorine, what must be present in the bacti sample bottle?

What is the time frame for which all bacti samples must be analyzed?

What does the presence of coliform bacteria in water indicate may also be present?

What are the most common sources for nitrate in water?

What is the most common adverse health effect associated with higher levels of nitrate in drinking water?

Why should lead and copper samples be collected early in the monitoring period?

Where are lead and copper samples collected from?

How long must the water be standing in the pipes prior to taking a lead and copper sample?

What types of follow-up actions are required if my system has a lead or copper ALE?

Where must VOC samples be collected?

What is an important action to take with the area around the sampling location before taking a VOC sample?

What is added to a VOC sample bottle if chlorine is add to the water system?

Care must be taken to avoid what in a VOC sample bottle?

What are the common sources for SOCs in water?

What is added to a SOC sample bottle if the system is adding chlorine?

What is the source of radionuclides in water?

Where should radiological samples be collected from - an entry point or the distribution system?

What is a Tier 1 public notice, and when is it required?

When is it required for a public water system to collect DBP samples?

Chapter 5- Water Systems

5.1- WATER SYSTEMS

A water system is made up of different elements including the ***source, treatment, pumps & pump facilities, controls, distribution system, and finished water storage.*** The DNR enforces regulations for design, construction, installation, operation, and maintenance of all these elements of a water system. These regulations are found in the Wisconsin Administrative Code. The complete codes can be found on the internet by doing a search for "Wisconsin Administrative Code" and navigating to the corresponding code.

5.2- WELL / PUMP

As explained in Chapter 2, the water source for most small water systems in Wisconsin is groundwater. Each type of well or pump has specific maintenance and operation requirements that are not covered in this manual. The well owner and operator should consult with their well pump supplier and learn the maintenance requirements for their equipment. There are some general operation and maintenance principles that all operators should follow:

- Keep the area around the well clean and free of all potential sources of contamination. Do not store chemicals or petroleum products near the well.

- Inspect the well frequently. Make sure the well cap is securely in place and that there are no holes or gaps where insects or other animals can enter.

- Inspect the well vent screen and make sure it is securely in place.

- Listen to the well pump while it is operating. An experienced operator can identify and solve potential problems by simply listening to the well pump while it is in operation. In many cases, slight variations in noise are caused by wear to components that could cause system failure.

- For vertical turbine motors, grease pump and motor bearings per manufacturer specifications.

- Monitor the water quality. Some changes in water quality are caused by malfunctioning equipment.

- Monitor the gpm pump discharge rate and the static and pumping water levels. Declining gpm pump rates and/or water levels can be an indication that a well rehabilitation is needed.

5.3- WATER STORAGE

Each water system has its own unique requirements for water storage. These depend on such factors as the system's pressure, normal water usage, maximum water usage, low and peak demand, and fire protection requirements.

Water storage facilities come in different types including ***ground storage***, ***elevated tank***, ***standpipe,*** and ***hydro-pneumatic tank*** (pressure tank). Depending on their type, they are usually constructed of either steel or concrete. Their primary purpose is to store water during periods of low demand for distribution during periods of high demand. As with pumping equipment, each style and brand of storage facility has its own specific operation and maintenance requirements.

According to Wisconsin Administrative Code, water storage facilities, pressure tanks with hatches (where practicable), and other devices with hatches such as iron filters, softeners, and other treatment devices must be inspected every 5 years. Exterior inspections of vent and overflow screens and hatches shall be conducted once per year.

Where possible, things to look for include:

- cracks, chipped or peeling paint
- leaking covers or valves
- screens on vents
- improperly terminated vents and overflow pipes
- improperly working gauges
- water logged/low pressure in pressure tanks
- corrosion of metal surfaces

Maintenance (as needed) shall include removal of sediment, cleaning of biofilm, restoration of interior and exterior coating systems to prevent corrosion, cleaning and repair of sight glasses and air volume controls, and exercising valves.

Some general operation and maintenance tasks for all water storage facilities are:

- Identify and repair storage tank leaks as soon as possible. For all concrete ground reservoirs with cracks or signs of leakage, the top shall be soaked with water, and the interior shall be checked for leaks. In a water system, no leak ever repairs itself.

- Repainting interior metal surfaces.

- Repair the roof, vents, and overflow pipes.

- Inspect the facility for corrosion. It is important to identify and eliminate any corrosion of storage tanks as soon as possible. Left unrepaired, corrosion can lead to failure of the tank and the need for replacement. The easiest way to prevent corrosion is to use protective coatings. Owners may also consider using an anti-corrosion method such as cathodic protection. Contact your regional water supply representative before installing any protective coatings or cathodic protetion to see if any approvals are required before starting work.

- Pressure tanks must be flushed regularly to remove sediment.

- Additional inspection requirements apply to water storage facilities 10,000 gallons or larger which include inspections being conducted by a professional tank inspection firm or by a registered professional engineer. Maintenance shall include removal of sediment and biofilm prior to evaluation of structural, mechanical, and coating systems. Repairs shall be provided as necessary to ensure good working condition. Interior and exterior paint coatings for steel elevated water storage tanks or treatment structures shall be inspected by a person trained to evaluate the integrity of the paint system and repainted as necessary to maintain structural integrity.

- Scheduled maintenance should be undertaken when it will least inconvenience customers. If this is not possible, give adequate notification in advance.

5.4- DISTRIBUTION SYSTEM

A water distribution system is made up of different components including ***pipes, mains, valves, hydrants,*** and ***meters***.

5.4.1- MAINS AND SERVICES

The common names for the pipes that act as conduits for water to travel through a distribution system are known as ***water mains*** and ***water services***.

A. Water Mains

Water mains are the pipes that carry water from the source to the storage facilities and throughout the distribution system. They can be made of different materials. The most common are ***ductile iron*** and ***plastic***. However, many older mains are made of galvanized iron, cast iron, concrete, asbestos cement, and even wood.

Factors to consider when choosing a water main material are its durability, cost, installation, conductivity, and repair and ease of connection for future expansion or customer connection. The material must be approved by the DNR when mains are installed under public streets or right-of-ways, or by DSPS when mains are installed under private property. Wisconsin Administrative Code requires that pipes used for water mains must be cast iron, ductile-iron, reinforced concrete, polyvinyl chloride (PVC), high density polyethylene (HDPE), copper, or materials specifically approved by the DNR for restricted or experimental use. All pipes must meet American Water Works Association (AWWA) standards, unless approved by the DNR for special low-pressure applications. DSPS approves plumping pipe for small systems.

Another important factor in choosing water mains is their size (diameter). The size of the main will determine how well it transmits water throughout the system. This is due to the fact that smaller pipes allow less water to flow through them due to their size restriction and the friction that is created between the water and the inside walls of the pipe. This loss in flow is called ***friction loss***.

For main sizing in community water systems, Wisconsin Administrative Code NR 811 requires that:

- The minimum diameter pipe to provide water for fire protection and supply hydrants is 6 inches.

- The minimum flow required for water mains supplying hydrants is 500 gallons per minute (gpm) at 20 pounds-per-square-inch (psi) residual pressure.

- Water mains must be designed and operated to maintain a minimum residual pressure of 20 psi at ground level at all points in the system and under all flow conditions. Normal static pressure must be no less than 35 psi and no more than 100 psi respectively at ground level.

- Dead-end mains or other low-flow portions of the distribution system should be flushed annually or as needed to minimize water stagnation. Water stagnation can lead to discoloration and unpleasant tastes and odors as well as bacteriological concerns.

B. Water Services

The pipes that carry water from the water mains to the customers are called ***services*** or ***laterals***. Today, the most common water service materials are plastic and copper. Many older water services were made of galvanized-iron and lead.

As with mains, the sizing of water services is an important factor, and they should be sized according to the needs of the customer. The higher the flows required, the larger the service needed and vice versa.

C. Pressure and Flow

One of the most commonly misunderstood areas for customers is the difference between ***water pressure*** and ***water flow***. In many cases, a customer will notify the operator that they do not have any water pressure when, in fact, they are describing a low flow situation.

System pressures will generally fluctuate very little during normal conditions, though low pressure can be caused by high water demand somewhere else in the system or by pump or pressure tank problems. Low flow problems can be caused by piping mineral build-up, partially closed valves, or the failure to adequately interconnect mains and pipe fittings, such as elbows and tees which cause water to lose velocity as it changes direction. When an operator is faced with a problem of dealing with a lack of water, it is important to first identify if it is caused by a lack of pressure or a lack of flow.

D. Leak Detection

The most common maintenance problem with water mains and services is leaks. Typically, leaks will occur at points where different pipes interconnect such as elbows, bends, tees, and fittings. However, it is also common for pipes to break due to the earth's natural movement, freezing, or improper installation.

In most cases where there is adequate pressure, water escaping from leaks will generally come to the surface near the location of the leak. However, this may not always be the case; exceptions include: when leaks occur on hills, near underground rock crevices or sewer lines, or underneath ground that is frozen. Modern leak detection devices are quite effective at locating such leaks. These devices typically employ sound detection to locate the leak by detecting the noise pressurized water makes as it escapes from pipes.

E. Water Hammer

Another cause of broken water pipes is called ***water hammer***. Water hammer occurs when flowing water in a system is immediately stopped due to a larger capacity pump, valve or hydrant being opened or closed too quickly. This creates tremendous force that can cause considerable damage. Always open and close valves and hydrants slowly.

5.4.2- VALVES

The mechanical devices used to isolate water pipes are called ***valves***. Valves come in a variety of styles, shapes and sizes, but their main purpose is to regulate or stop the flow of water. In a distribution system, there are two types of valves, ***main valves*** and ***service valves***. As their names indicate, main valves are installed on water mains, while service valves are installed on service lines.

A. Main Valves

Main valves should be located so that shutting one off affects as few customers as possible. They are generally installed at tees or crosses where two or more mains intersect. In many cases, they are used to make emergency repairs; therefore, it is important to ensure that they are accessible and in good working condition. To this end:

- Valves should be operated every 2 years at a minimum.
- Valve boxes should be kept free of debris so access can be achieved when needed.
- Valves should always be operated slowly to prevent water hammer.
- Maintain good maintenance records.

B. Service Valves

Another name for a valve used to isolate a water service line is a ***curbstop valve***. They are installed on the service line between a water main and a building, usually near a street curb. As opposed to a main valve, which is used to isolate a section of the water system or main, the curbstop valve is used to isolate a single building. To maintain proper operation of these valves, operators should:

- Exercise them at least every 2-5 years or sooner (required for community systems)

- Make sure that the locations of curbstop valves are known. Measure their location from a nearby building or object. Keep records/plans of their locations.

- Make sure that the service valve boxes are free of any foreign materials and that they are working properly.

5.4.3- HYDRANTS

In a distribution system, the device that allows water to flow quickly out of a main is called a hydrant. Hydrants are generally installed for two purposes, to fight fires and to flush water mains. As such, there are different types of hydrants.

Fire hydrants are equipped with fire hose connections. They are generally larger than flushing hydrants to allow large volumes of water to flow for fire-fighting. They are strategically located throughout a distribution system for ready access in the event of a fire.

Flushing hydrants (or blow–off hydrants) are generally smaller than fire protection hydrants. They are installed on dead-end lines and throughout the system, in low-use areas. Many flushing hydrants are equipped with smaller connections unsuitable for fire hose connection.

Regardless of whether they are used for flushing or fire-fighting, there are two styles of hydrants: dry-barrel and wet-barrel.

Wet-barrel hydrants have the operating valve at the top of the hydrant. The entire hydrant contains pressurized water.

Dry-barrel hydrants have a barrel that is empty of water, and the operating valve is located at the bottom of the barrel. This type of hydrant keeps the water below the frost line to prevent freezing. In Wisconsin, virtually every hydrant is a dry-barrel hydrant.

To ensure that hydrants are in working order, an operator should:

- Exercise hydrants every year and keep a record of these operations.

- Maintain hydrants in working order. Hydrants can become hard to operate and may require lubrication. If lubrication is required, follow the manufacturer's recommendations.

- Always open hydrants fully to close drain holes at bottom of barrel.

- Check hydrants in the fall to make sure they drain to prevent freezing.

- Pump water out of hydrants where necessary before freezing weather.

- Operate hydrants slowly to prevent water hammer.

- Repair hydrants as necessary.

- Keep records of operations, maintenance and repair.

5.4.4- METERS

The devices used to measure water flow and volumes used are known as ***water meters***. There are different types of water meters including ***positive displacement meters***, ***turbine meters, mag meters*** and ***compound meters***. Meters are always differentiated by size, with the size being the inside diameter of the entry and exit ports. For community water systems, the use of meters to measure the water used by customers for billing purposes is regulated by the Wisconsin Public Service Commission. In some cases for smaller systems, metering is regulated by the Department of Safety and Professional Services.

A. Positive Displacement Meters

Positive displacement meters measure water as it passes through a measuring chamber. The measuring chamber contains a piston or disc that rotates as the water passes through it. The piston or disc then turns a dial that records the amount of water used. This type of meter is used in normal and low-flow conditions and comes in sizes ranging from 5/8-inch to 2-inches. The 5/8-inch meter is most commonly used in single-family residential applications. The 3/4-inch meter is generally used for large residences, apartments, and businesses, where the service pipe is 1-inch. The 1-inch, 1½-inch, and 2-inch meters are usually installed in businesses, large apartments, hotels, and industrial buildings, depending on water demand.

B. Turbine Meters

Turbine meters measure water much like a windmill, with the water turning fins or blades as it passes through it. They are generally used in high flow conditions and are not as accurate as positive displacement meters. Turbine meters come in sizes of 2 inches and larger, and are used in hospitals, very large hotels and large industrial facilities. Electromagnetic meters, also known as mag meters, measure velocity using electromagnetic properties instead of the flow through mechanical measurement mechanisms.

C. Compound Meters

A compound meter is a positive displacement meter and a turbine meter in one unit. The turbine unit is in the lower part of the meter housing, and the positive displacement metering chamber is above it. For normal and low flow conditions, a valve closes and diverts the water through the upper meter. During high flow conditions the valve opens, allowing the water to pass through the lower turbine unit. Compound meters come in sizes of 2 inches and larger and are normally used in schools or apartments where substantial fluctuations in water usage occur.

D. Choosing the Right Meter

In choosing the right meter for a customer, the operator must take into account the low flows, normal flows, and peak flows that the meter will encounter. The accuracy and life of the meter will depend on the type of meter chosen. It is also important to correctly size the meter. The meter should never be any larger than the pipe it is connected to. This is because the size of the pipe will determine the amount of water that can go through the meter. The meter should also be provided with enough straight piping upstream and downstream per manufacturer's recommendations. Laminar flow is essential for meter accuracy. Flow pacing water meters are required when the flow through the pump discharge piping is variable and the water system chemically treats the water.

E. Meter Reading Methods

Water meters can be read in a variety of ways, depending on the meter style. The most basic style is the ***direct-read meter*** which is read by looking at the numbers on the top of the meter dial. The number from the previous reading is then subtracted from the present reading to determine the amount of water used between the two readings.

There is also the ***generating meter*** that relays the signal from the meter to a registering head mounted at a remote location. Both the direct-read and generating meter must be read manually (visually) to determine the water usage.

The newer generation of meter is called the ***remote-read meter***. This meter generates a signal from the meter that is read by a radio, a telephone, or a hand-held computer. These types of meters allow for readings to be obtained quickly and more efficiently than direct-read and generating meters.

F. Meter Testing and Repair

In Wisconsin, requirements for the frequency and accuracy of testing for water meters are established and enforced by the ***Wisconsin Public Service Commission (PSC)***. The regulations are important to ensure that both the owner and the customer are correctly compensated and charged for the amount of water used. Although there are conditions which can change the testing frequency, in general:

- Residential meters receiving water from a community water system are to be tested once every 10 years.

- Remote outside meter and automatic meter reading systems receiving water from a community water system are to be tested each time the meter is tested.

- Industrial and commercial meters receiving water from a community water system are to be tested once every 1 to 4 years, depending on size.

- Station meters in a community water system are to be tested once every 2 years. ***Station meters*** are used to measure the amount of water pumped into the distribution system. They should be installed on the inlet line of pressure tanks and storage reservoirs and not on the outlet lines.

- To test a meter, the meter is removed from the building and placed into a meter testing device through which flows a known amount of water. This is generally done using specifically sized tanks.

- Mag meters are generally tested in place.

Important Note: When removing meters, always use a jumper cable to protect yourself. Most buildings' electrical systems are grounded to the plumbing system. Failure to use a jumper cable when removing a meter can result in serious injury or death.

The amount of water that the meter records is then compared to the known amount of water that passes through it. If the meter records the exact amount of water, it is 100% accurate. If not, it will record a lower percentage. Meters below 95% accuracy should be repaired or replaced.

5.5- TREATMENT FOR MICROBIAL CONTAMINANTS

5.5.1- Disinfection

Disinfection is a process of using chemical or physical methods to destroy or inactivate harmful pathogens that might be present in a well or surface water. Disinfection is also used to protect the water in the distribution system from pathogen regrowth or re-contamination. Disinfection can be accomplished using a variety of treatment techniques, the most common being chemical treatment such as chlorine, chloramines (chlorine combined with ammonia), chlorine dioxide, ozone, and ultraviolet (UV) radiation. As mentioned in Chapter 4, the use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering baceteriological treatment for your system.

By far, the most common chemical treatment used is chlorine. If UV or ozone are used, chlorine must be added to the water to establish a disinfectant residual in buried water supply lines.

5.5.2- Chlorination

Chlorine is added to water in a variety of forms: ***gas***, ***liquid***, and ***solid***. Chlorine gas is a greenish yellow gas that has a familiar and pungent smell. Gas chlorination utilizes pressurized cylinders and regulators that control the amount of chlorine being added. Liquid or solid chlorination uses feed pumps that pump the chlorine or dissolved chlorine into the system. Chlorine feed pumps should be cleaned and flushed with muriatic acid as needed. Hoses should be checked regularly for cracks and deterioration. In fact, routine servicing of all chemical feed equipment is necessary.

5.5.3- Chlorine Monitoring

When chlorine is added to the water system, you must monitor the amount of chlorine added and the levels of chlorine in the distribution system. Common terms associated with monitoring chlorine levels are:

> ***Dosage*** - Amount of chlorine added per unit volume of water (i.e. lbs/gallon or mg/liter).
>
> ***Chlorine demand*** - Amount of chlorine that reacts with contaminants and inorganic compounds (iron, manganese, etc.) and organic matter in the water.
>
> ***Residual*** - Chlorine level remaining after the initial chlorine demand is satisfied.

Free chlorine residual - Amount of free chlorine remaining after the chlorine demand is met.

Combined chlorine residual - Free chlorine that is combined with ammonia or other nitrogen-containing organic matter.

Total chlorine residual - The sum of free chlorine residual and combined chlorine residual.

5.5.4- Chlorine Levels

Water systems that add chlorine must test for the residual amount at the ends of their distribution system a minimum of twice weekly. The amount of chlorine added must also be monitored daily, either by weight or by volume.

All systems that chlorinate must maintain a trace amount at the extremities of the system. Systems required to chlorinate must also maintain a minimum of 0.2 mg/L chlorine residual at the entry point to the system.

Systems required to perform emergency chlorination must reach a free chlorine residual of at least 0.5 mg/l within 4 hours of DNR notification and maintain it throughout the entire distribution system.

5.5.5- Residual Chlorine Testing Methods

The use of the "color wheel" is no longer permitted for measuring residual chlorine. This measurement must now be done with a pocket colorimeter or other method that is specifically designed to measure residual chlorine. The LaMotte DC1200 or the HACH pocket colorimeter II are two instruments that can be used for this measurement. Other methods may be used as long as they can measure chlorine residuals to the nearest 0.1 mg/L in the range below 0.5 mg/L and to the nearest 0.2 mg/L in the range between 0.5 to 2.0 mg/L. Follow the instructions provided by the manufacturer when making this measurement.

5.5.6- Chlorine Safety

Chlorine is an extremely hazardous substance. Chlorine gas is especially dangerous and is not recommended for use by small water systems. Instead, consider using an electronic positive displacement chemical feed pump or a peristaltic chemical feed pump to deliver liquid chlorine (sodium hypochlorite) to your system. NSF standard 60 approved chlorine must be used and delivered in properly labeled containers.

When using and handling liquid chlorine, be sure to always wear an apron and proper gloves and goggles. You should also have an emergency eye-wash station and shower nearby. It is recommended that the chemical feed equipment be housed in a separate room with forced air ventilation.

Additional precautions must be taken when chlorine gas is used. The chlorine gas must be stored in a properly ventilated separate room. There must be one complete air change per minute whenever the room is occupied. Since chlorine fumes are heavier than air, the exhaust fan suction must be located near the floor. Make sure the exhaust fan discharges away from all building air inlets and other structures and that it is not blocked by snow or other obstructions. Chlorine gas scrubbers may also be required. The exhaust fan switch must be located outside the entrance to the chlorine room. Air inlets must be located near the ceiling. Self contained breathing apparatuses must also be available unless arrangements have been made to have the local fire department respond to gas leaks.

5.5.7- Ultraviolet (UV) Disinfection

Ultraviolet disinfection is a method whereby water is passed through a device where it is exposed to ultraviolet light. The UV light is produced by low-pressure or medium-pressure mercury vapor lamps. The amount of UV radiation that the water is exposed to is determined by the number of lamps used, the intensity of the UV light, the cloudiness of the water, and the amount of time the water is in the device.

UV disinfection is effective at disinfecting water containing microorganisms such as protozoans that are resistant to chlorine. Its drawbacks include lack of any residual in the distribution system, effectiveness dependent on clarity of the water, limitations as to the amount of water that can be treated at one time, and the current inability to conveniently measure the treatment effectiveness.

5.5.8- Ozone Disinfection

Ozone disinfection utilizes the addition of ozone (O_3) to the water. Ozone must be generated on site, and then, typically, the ozone has to be quenched following the treatment vessel. Because ozone is a powerful oxidizer, it is effective at killing pathogens. In Wisconsin, it is more commonly used at surface water treatment facilities and at groundwater systems that have few options other than to treat unsafe groundwater. Like UV, its disadvantage is that it does not leave a disinfecting residual in the distribution system.

5.6- TREATMENT FOR CONTAMINANTS

As mentioned in Chapter 4, the use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering any of the following treatment approaches to remove any regulated contaminants from your water system.

5.6.1- Lime Softening

Lime softening is used to soften water by adding hydrated lime to precipitate out calcium carbonate and magnesium. These materials are removed by an upflow clarifier in the sludge. The water is then treated with carbon dioxide to balance the pH and is then filtered.

5.6.2- Ion Exchange

Ion exchange includes cation and anion exchange. Cation exchange is used for water softening. Hardness-causing ions such as calcium and magnesium are exchanged with sodium ions, thus removing them from the water. Cation exchange is also used for removing radium and sometimes manganese.

Anion exchange is used for the removal of nitrate and uranium. It can also be used for arsenic removal; however, its effectiveness depends on the type of arsenic present and the chemistry of the source water.

5.6.3- Reverse Osmosis (RO)

Reverse osmosis (RO) is a process in which water containing a high concentration of solids is pumped under pressure through a semi-permeable membrane. The water that has passed through the membrane is low in solids, leaving behind a waste stream high in solids. Reverse osmosis is quite effective at removing most inorganic contaminants. Membranes with larger pore openings are available to reduce the cost of treatment when the solids content of the water to be treated is not as elevated.

5.6.4- Aeration

Aeration is a process in which water is mixed with air in a chamber or tower filled with packing material or another mechanism to disperse the water and allow for sufficient contact time with air. As the water trickles down over the material or mechanism, air is forced upward, “stripping” the contaminants from the water. Aeration or “air stripping” is quite effective at removing volatile organic compounds (VOCs), hydrogen sulfide, and radon gas.

5.6.5- Adsorption using Granular Activated Carbon (GAC)

Adsorption is a process in which organic contaminants become affixed to the surfaces of granular activated carbon as water passes through the carbon bed. In some cases, this process is used in conjunction with aeration to increase the effectiveness of the organic chemical removal. Granular activated carbon is effective at removing many synthetic organic contaminants (SOCs) and volatile organic contaminants (VOCs).

5.7- CORROSION CONTROL

Corrosion in water systems is defined as the electrochemical interaction between a metal surface (such as pipe wall or solder) and water. During this interaction, metals can be transferred into the water as metal ions. These ions can also re-attach to the surfaces of pipes in other areas of the distribution system. The type of corrosion that occurs in a given water sytem will depend on the type of plumbing materials present in the water system. The most common types of corrosion in drinking water include: (1) uniform corrosion, where the electrochemical interaction occurs along the pipe wall, resulting in a relatively uniform loss of metal across the entire surface; (2) non-uniform corrosion, where metal is lost from a localized point, causing pitting; and (3) galvanic corrosion which comes from a coupling of dissimilar metals.

While it is important to understand different corrosion mechanisms, the Lead and Copper Rule is specifically concerned with controlling *metals release* (i.e. release of lead and copper) into the water. Metals release is a function of the reactions that occur between the metal ions released due to corrosion and the physical, chemical, and biological characteristics of the water and the metal surface. These characteristics can include: source water quality (i.e pH), presene and/or absense of other metals (i.e. iron and manganese), utilization of drinking water treatments not related to lead and copper (i.e. chlorination for disinfection), water use, water temperature, physical disturbances, and changes to source water and drinking water treatments.

Methods of corrosion control treatment in a distribution system may include pH/alkalinity adjustment, the addition of phosphates, and/or the addition of silicates (information on the use and effectiveness of silicate-based corrosion inhibitors continues to be limited and more research is needed). In some instances, systems may use a combination of treatments to get the desired effect of lead and copper reduction (i.e. the use of phosphates and pH adjustment).

Corrosion control treatment can be characterized by two general approaches to inhibiting lead and copper release: (1) forming a precipitate in the potable water supply which deposits onto the pipe wall to create a protective coating; and (2) creating a passivating layer causing the distribution system pipe material and the water supply to interact and form metal complexes on the pipe surface (existing scale deposits are used to form a barrier film of less soluble metal carbonates or phosphate compounds on the inner pipe surface). This barrier layer of metal complex isolates the lead or copper plumbing materials from the water supply and minimizes dissolution.

Pipe scales are an important component of understanding lead and copper release. Scales can have layers and are influenced by treatment history. The characteristics of the scale and its structure dictate the amount of lead or copper that is released into the water. If conditions favor the formation of insoluble, adherent scale (i.e., scale that adheres well to the pipe wall), the rate of metals release will be low. However, if scales do not adhere well to the pipe wall or if they are very soluble, the release of metals may be greater. Other compounds in the water including aluminum, iron, manganese, and calcium can significantly influence scale formation and properties. The type of scale will also dictate how susceptible it is to releasing particulate lead following physical disturbances (i.e. infrastructure work).

As mentioned in Chapter 4, the use of any treatment device or technique requires prior approval from the DNR. For NN systems, prior approval is also required from DSPS. Call your DNR representative for details if you are considering corrosion control for your water system.

5.8- CROSS CONNECTIONS

Cross connections are connections that link potable water (water suitable for human consumption) to nonpotable water (water not suitable for human consumption). Cross connections can cause contamination when a loss in water system pressure allows water to flow back into the distribution system from an outside source. This is called ***back flow*** or ***back siphonage*** and can occur during a water main break or when a main is shut down for repairs. ***Back-pressure*** can also occur when a customer's water supply is at a higher pressure than the pressure in the water system. Examples of this could be a power-washer or a boiler system.

Types of back flow prevention devices include ***air gap separation***, ***reduced pressure devices, double check valves, pressure vacuum breakers,*** and ***atmospheric vacuum breakers.***

A good cross connection program includes inspections of buildings to identify and address unprotected cross connections and prevention of all future unprotected cross connections to the last flowing tap or end-use device. In addition, a time schedule for public education materials, surveys, and follow up surveys of consumer premises for cross connections (including appropriate record-keeping) should be established.

5.9- WATER SYSTEM MAPPING

Water system operators should keep a map of the water system on hand. This can be especially useful when system repairs or upgrades are necessary or in an emergency. Maps do not need to be elaborate, but they should be accurate and current. Items that should be listed on maps include streets, valves, hydrants, laterals, water mains, wells, and water storage facilities. If possible, size, depth, material, and measurements of each item should be included on the maps.

5.10- SAFETY

All safety codes for privately-owned water systems are established and enforced by the ***Occupational Safety and Health Administration (OSHA)***. Water system operators should know and follow all safety regulations and manufacturer-recommended safety precautions.

5.11- SECURITY

A water system may be significantly damaged due to an unforeseen event. A severe event may cause disruption of water service, contamination of water served, or damage to waterworks facilities. Efforts should be taken to have redundancy in the water system where possible and keep facilities secure at all times. Vandalism to water supplies may be costly and impact human health considerably.

5.12- EMERGENCY PREPAREDNESS

Operators should always be aware of security concerns and take necessary precautionary measures when appropriate. It is recommended that every water system have a plan in place for responding to an emergency that includes, at a minimum, a list of local and state emergency contacts.

Other-than-municipal (OTM) water systems are required to have a current ***Emergency Operations Plan*** in place. This plan must include:

- A list of pump installers, plumbers, electricians, or other contractors that would be available to respond in emergency situations.
- Procedures for obtaining a back-up water source in the case of an emergency.
- The local DNR representative's contact information

Review Questions for Water Systems

1. Name the main components of a water system.

2. Name four types of water storage facilities.

3. What are the different components of a water distribution system?

4. What are the two names for the pipes that carry water from the source to the customer?

5. What are the factors an operator should consider when choosing pipes for a distribution system?

6. What is the difference between water pressure and water flow?

7. What reaction can occur in a water system when a valve or hydrant is closed too quickly?

8. What device is used in a distribution system to regulate or shut off the flow of water?

9. What are the two main uses for hydrants?

10. Name the three types of water meters and explain what each is designed for.

11. In Wisconsin, what agency regulates the metering of customers?

12. Name the three most common methods used for disinfection.

13. What are the three forms of chlorine available to be used for disinfection?

14. What is the name for the chlorine available in a water system after the demand?

15. What is the biggest drawback of using UV or ozone disinfection?

16. Name two processes used for softening water.

17. Name two methods used for treating lead and copper releases in a distribution system.

18. Name two factors (other than corrosive water) that can influence lead and/or copper release in distribution systems.

19. What type of pipe scale is best for reducing lead and copper release: well-adhering insoluble scales or poor-adhering soluble scales?

20. Name the agency responsible for safety codes at privately owned water systems.

21. What kind of information would you would want to have on an *emergency response plan* for your water system?

WATERWORKS MATH

Conversions

1 psi (pound per square inch)	=	2.31 feet of elevation
Minutes in a day	=	1,440
1 cubic foot of water	=	7.48 gallons
Weight of 1 cubic foot of water	=	62.4 pounds
Weight of 1 gallon of water	=	8.34 pounds
Liters of water in a cubic foot	=	28.317
Liters of water in a gallon	=	3.785
1 milligram per liter (mg/L)	=	1 part per million (ppm)
1 ppm or 1 mg/L	=	1,000 parts per billion (ppb)
1 ppb	=	0.001 ppm or 0.001 mg/L
1 million gallons per day (mgd)	=	694 gallons per minute (gpm)
1 cubic foot per second (cfs)	=	450 gallons per minute
Water per foot in a 1” pipe	=	0.041 gallons
Water per foot in a 2” pipe	=	0.163 gallons
Water per foot in a 4” pipe	=	0.653 gallons
Water per foot in a 6” pipe	=	1.469 gallons
Area of a square or rectangle	=	Length x width
Area of a circle	=	0.7854 x diameter^2
Area of a circle	=	3.1416 x radius^2
Volume of a cylinder	=	0.7854 x diameter^2 x depth
Volume of a square of rectangle	=	Length x width x depth
Pounds of chlorine needed	=	Million gallons x ppm x 8.34

Examples

A well pumping 100 gallons per minute can pump how many gallons per day?

(1,440 x 100 = 144,000 gallons)

How many cubic feet are in 20 gallons of water?

(20 / 7.48 = 2.67 cubic feet)

How many cubic feet of water are in a reservoir 20 feet long, 15 feet wide, and 10 feet deep?

(20 x 15 x 10 = 3,000 cubic feet)

How many gallons of water are in this same reservoir?

(3,000 x 7.48 = 22,440 gallons)

How many pounds of chlorine would it take to disinfect this same reservoir to a concentration of 0.5 ppm?

(0.022440 x 0.5 x 8.34 = 0.09 lbs)

How many gallons of water are in a circular reservoir that is 30 feet across and 10 feet deep?

(0.7854 x 30^2 x 10 x 7.48 = 52,873 gallons)

With a well that pumps 50 gallons per minute, how long in minutes or hours will it take to fill this same reservoir?

(52,873 x 50 = 1,057 minutes or 17.6 hours)

If you wanted 50 pounds of pressure at a given point of a water system with a gravity feed water reservoir, how many feet above that point must the water in the reservoir be?

(50 x 2.31 = 115.5 feet)

How many gallons of water are in a 2 inch water line that is 400 feet long?

(0.163 x 400 = 65.2 gallons)

If you wanted to flush out that same line through a faucet that flows at 20 gallons per minute, how many minutes would it take?

(65.2 / 20 = 3.26 minutes)

A 2-gallon per minute leak loses how many gallons in a month?

(1440 x 2 x 31= 89,280 gallons)

5 parts per million is equivalent to how many milligrams per liter?

(5 mg/L)

5 parts per billion is equivalent to how many parts per million? How many micrograms per liter?

(0.005 ppm) (5 ug/L)

If you had to recoat the bottom of a circular reservoir 20 feet across, how many square feet would you be covering?

(0.7854 x 20^2 = 314.16 square feet) or (3.1416 x 10^2 = 314.16 square feet)

Appendix A-
Sanitary Survey Checklist

Appendix A- Sanitary Survey Checklist

Other-Than-Municipal Public Water System

Question
I. Is the source adequate (protection, physical components, capacity)?
A. Are there no new contaminant sources identified?
B. Does the well(s) meet the appropriate construction requirements including the elimination of dual aquifer situations? (811.12(1))
1. Are well construction reports on file and accurate including reconstruction? (811.12(3))
C. Are unused wells properly abandoned (including report on file with DNR)? (811.13 (1) - (8))
D. Is the source capacity adequate to meet current and future demand?
E. Is the backup source adequate to meet demand including any emergency interconnection? (811.26)
F. Are all monitoring waivers valid? (NA if no waivers granted)
G. Is vulnerability assessment material accurate and up-to-date? (809.205(5))
H. Are all sources protected from flooding?(811.09(g)); (811.12(5)(b))
I. None of the sources require groundwater under the direct influence of surface water review? (810.02(25)); (810.27); (811.02(34)); (811.16(2)); (811.17(2))
J. Are all sources adequately protected from unauthorized access?(810.23); (811.25(c))
K. Is the pump base adequate? (extends min. 12" above floor) (811.31 (1)) & (811.32 (1)) (6" high collar)
II. Are the pump(s), discharge piping, pump facility(ies) and controls adequate?
A. Is the pumping capacity adequate, with the largest unit out of service, to ensure continued operation (firm pumping capacity) (N/A if 50 or less living units)? (811.26(2))
B. Is the pump facility protected from flooding (i.e. pump house floor >2' above flood elevation)? (811.25(1)(d))
C. Is the pumping facility(ies) adequately protected against unauthorized access? (810.23) & ((811.25(c)) for CWS's)
D. Is the capacity of the pump(s) sufficient? (811.26); (811.29)
E. Is the condition of the pump(s) satisfactory? (810.03)
F. Does the pumping system(s) use only approved lubricants? (811.31 (2))
G. Are pumping controls adequate and in good working condition?
H. Are the discharge type and/or appurtenances appropriate for the system?
I. Does the discharge piping and appurtenances meet NR 811 requirements? (811.37)
J. Is the condition of the pump facility(ies) satisfactory? (NA if no facility) (811.25)
K. Does the pump facility(ies) meet NR 811 requirements? (NA if no facilities) (811.25)
III. Is the water treatment adequate? (NA if no treatment)
A. Is the current treatment adequate for protecting public health, given source water quality?
B. Is there adequate water quality monitoring equipment at the facility? (810.03)
C. Is there an adequate means for determining chemical usage? (NA if no chemical addition) (811.40(1)(g))
D. Is the chemical storage adequately protected from contamination? (overlapping cover, sealed openings, made of appropriate material, etc.)(NA if no solution tank) (811.40)
E. Is the O & M of the treatment facility(ies) adequate? (NA if no treatment facility) (810.03)
F. Is the condition of the treatment equipment satisfactory? (NA if no treatment, including emergency treatment) (810.03)
G. Is monitoring of treatment system performance adequate? (NA if no treatment) (810.03)
H. Are appropriate record keeping practices used? (NA if no treatment) (810.40)
I. Is the chemical(s) used in treatment NSF approved? (NA if no treatment) (810.09(1))
J. Are chemical storage/spill containment practices adequate? (NA if no treatment) (811.40(1)); (811.39(3))
K. Are chemical handling and spill response protocols adequate? (NA if no treatment) (811.40 (2) & (3))
L. Do operators have appropriate qualifications for the system treatment process(es)? (NA if no treatment) (810.04)
M. Are adequate security measures in place to prevent unauthorized access to treatment facility(ies)? (NA if no treatment) (810.23)
N. Is the treatment equipment reliable? (NA if no treatment)
O. Does the treatment process(es) adequately respond to changes in raw water quality? (NA if no treatment)
P. Are there sufficient fail-safes to ensure the continued operation of the treatment process(es)? (NA if no treatment) (811.39); (811.48(1)(c))
Q. Is the water system protected from accidental chemical overfeed? (anti-siphon device & power outlet linked with pump power) (NA if no chemical addition) (811.39)
R. Is the treatment system(s) protected from flooding? (NA if no treatment) (811.25(1)(d))

Appendix A- Sanitary Survey Checklist

Other-Than-Municipal Public Water System

Question
S. Does the installation of all water treatment devices meet the requirements of NR 811? (NA if no treatment) (811 Sub. VI & VII)
IV. Is the finished water storage facility(ies) adequate, including pressure tank(s)? (NA if none)
A. Are water storage facilities inspected at least once every 5 years? (810.14)
B. To the best of your knowledge, do the reservoirs meet all of the other NR 811 requirements and is the O & M of the storage facilities adequate? (811 Sub. VII - Hydro Pneumatic Tanks & Sub. IX - Storage Facilities)? Check most recent reservoir inspections.
C. Does the paint on the outside of the storage facility(ies) look adequate and clean with no apparent corrosion? (810.14)
D. Is the storage capacity sufficient to meet water use demands - (NA for larger water systems)? Please refer to spreadsheet calculations. (811.62)
E. Are adequate security measures in place at the storage facility(ies) to prevent unauthorized access? (NA if no storage) (811.64(2)(d))
F. Is emergency power available and adequate for pumping from ground reservoir(s)? (811.27)
G. Is the storage facility(ies) protected from flooding? (NA if no storage) (811.63(1)(a), 811.61(1) Hydro-Pneumatic Tanks)
H. Is storage protected from contamination? (NA if no storage) (811.62 & 811.63 & 811.61 (1) (Hydro-Pneumatic Tanks))
I. Is the condition of the storage components satisfactory? (NA if no storage) (810.03)
V. Is the distribution system adequate? (NA if no distribution system)
A. Is the system maintaining a minimum residual pressure > 20 psi at all points in the distribution system under all conditions of flow? (811.70(4))
B. Are the disinfectant residuals adequate? (NA if no disinfection or no distribution system) (810.09); (811.42(5))
C. Is there an adequate corrosion control program? (NA if no dist. system or not required) (809.54(4))
D. Are all cross-connections to potential contamination sources eliminated? (810.15)
VI. Is water system operations and management adequate?
A. Are operators up to date with current standards, problem areas in the water system, current issues, new contaminants, regional source water problems, etc.?
B. Is the system maintaining and practicing a comprehensive Emergency Operations Plan? (contacts, communications, mutual aid, auxiliary power procedures, loss of system pressure, emergency chlorination plan) (810.23(2))
C. Have measures been taken to enhance the security of the water supply system? (Recommendations listed in security manual)
D. Does the system have adequate manpower, training and equipment to perform all necessary duties to provide an adequate quantity of safe drinking water to consumers? (810.03)
E. Have past inspection deficiencies, outlined in previous inspection reports, been corrected as required? (Review / initiate stepped enforcement process)
F. Are customer complaints logged and responded to as necessary?
G. Has the system made an effort to stay in compliance with state regulations?
H. Does the system provide adequate operator support/training? (810.03)
I. Does the system have any water management and conservation plan?
J. Is there an appropriate priority list for addressing problems in the system?
K. Are there adequate long- and short-term plans for system operation and maintenance? (810.13)
L. Is there an adequate public notification plan? (809.950)
M. Does the operator understand: Regulatory costs? Water system budget (annual budget)? Upgrade and maintenance costs for the next 3-5 years?
N. Does the system have adequate revenue to meet regulatory requirements? 810.03
O. Does the system have adequate revenue to cover emergency costs? 810.03
VII. Is all monitoring/reporting/data verification adequate and accurate?
A. Has the system been in compliance with their monitoring requirements with respect to samples taken and frequency?
B. Are there updated monitoring plans on file with the department for bacteria (809.31(1)(a)), lead/copper ((809.547(1)(a)) and disinfection byproducts ((809.565(6))?
C. Does the system appropriately implement sampling plans in order to meet monitoring rule requirements? (sample sites spatially appropriate and rotate from site to site)

Appendix A- Sanitary Survey Checklist

Other-Than-Municipal Public Water System

Question
D. Has the system been in general compliance with regards to water quality?
E. Has water quality generally not degraded since the last sanitary survey?
F. Has the system published adequate Consumer Confidence Report(s)? (809.833)
G. Are monthly operating reports complete and submitted in a timely manner (required for MC's, OTM's that have treatment or chemical addition, all hi-caps)? (810.07)
H. Have the appropriate public notices been issued in a timely manner (Tier 3 public notices may be published in the CCR per (809.950))?
I. Does the monitoring data reported to the DNR match that on file in the system's records? (809.82)
J. Are sampling faucets and faucet locations appropriate for each type of sample (including raw, entry point and distribution)? (811.37(5))
K. Is the sampling procedure for each type of sample appropriate?
L. Were there no recent water quality and/or quantity complaints from customers?
M. Can the system chlorinate within 4 hours if there is a bacti unsafe?
VIII. Has the operator(s) fulfilled certification requirements?
A. Is the operator(s) certified with appropriate grade of certification? (NR 114 Subchapter I or III)
B. Has the operator(s) fulfilled continuing education requirements? (NR 114 Subchapter I or III)
C. Is the appropriate "operator-in-charge" assigned to the water system and on file with the DNR? (NR 114 Subchapter I or III)
D. Is the operator(s) aware of renewal requirements and certification expiration date?
E. Does the system provide for adequate operator support/training?

Appendix A- Sanitary Survey Checklist

Non-transient Non-Community Public Water System

Question
I. Is the source adequate (protection, physical components, capacity)?
A. Is the well adequately separated from contaminant sources, including protection from flooding? (812.08)
B. If information available (i.e., construction report) does the well(s) meet the appropriate construction requirements?
C. Are unused wells properly abandoned? (NA if none) (812.26 (1)-(9))
D. Is the finished well height adequate? (> 12" post-1991, > 8" pre-1991, > 6" pre-1953) (> 2 ft if located in Floodway/Floodplain)
E. Is the well seal and venting code complying? (812.30)
1. Are all openings through well cap water-tight? (airline and other wires/lines) (812.30 (5))
2. Is the vent through the well cap code complying? (> 0.25 sq.in., w/screen, terminates 12" from floor, downward facing) (812.30 (3))
3. Is there a code complying raw water sample tap(s)? (812.34)
II. Are the pump(s), discharge piping, pump facility(ies) and controls adequate?
A. Is the pumping facility(ies) adequately protected against unauthorized access? (810.23) & ((811.25(c)) for CWS's)
B. Is the capacity of the pump(s) sufficient? (812.32 (1)(a)(2))
C. Are the pump(s) & pumping controls in satisfactory working condition?
D. Does the pumping system(s) use only approved lubricants? (812.32 (1)(b))
E. Does the discharge piping and appurtenances meet NR 812 requirements?
F. Does the pump facility(ies) meet NR 812 requirements? (NA if no facilities)
G. Is the pump facility(ies) protected from flooding? (casing height 2 ft. above flood elevation)(812.08)
III. Is the water treatment adequate? (NA if no treatment)
A. Does the department approved water treatment device installation meet approval conditions, including operations and maintenance? (NA if no Dept. Approved treatment) (812.37)
B. Is the current treatment adequate for protecting public health, given source water quality?
C. Is there adequate water quality monitoring equipment at the facility? (810.03)
D. Are the disinfectant residuals appropriate? (NA if no disinfection or no distribution system)
E. Is there an adequate corrosion control program? (NA if no dist. system or not required) (812.37 (3)(d))
F. Is the water system protected from accidental chemical overfeed? (anti-siphon device & power outlet linked with pump power) (NA if no chemical addition)
G. Is there an adequate means for determining chemical usage? (NA if no chemical addition) (812.37)
H. Is the chemical storage adequately protected from contamination? (overlapping cover, sealed openings, made of appropriate material, etc.)(NA if no solution tank) (810.09(1)(f))
I. Is the O & M of the treatment facility(ies) adequate? (NA if no treatment facility) (810.03)
J. Is the condition of the treatment equipment satisfactory? (NA if no treatment, including emergency treatment) (810.03)
K. Is monitoring of treatment system performance adequate? (NA if no treatment) (810.03)
L. Are appropriate record keeping practices used? (NA if no treatment) (810.40)
M. Is the chemical(s) used in treatment NSF approved? (NA if no treatment) (812.37 (2)(i))
N. Are chemical storage/spill containment practices adequate? (NA if no treatment) (812.37)
O. Are chemical handling and spill response protocols adequate? (NA if no treatment) (812.37)
P. Does the treatment process(es) adequately respond to changes in raw water quality? (NA if no treatment)
Q. Are there sufficient fail-safes to ensure the continued operation of the treatment process(es)? (NA if no treatment)
R. Is the treatment system(s) protected from flooding? (NA if no treatment)
IV. Is the finished water storage facility(ies) adequate, including pressure tank(s)? (NA if none)
A. Do all of the storage facilities meet NR 812 requirements? (NA if no storage) (812.33)
B. Are sufficient contamination prevention mechanisms employed? (NA if no storage)
C. Is the O & M of the storage facility(ies) appropriate? (NA if no storage) (810.03)
D. Is the storage capacity sufficient to meet water use demands? (NA if no storage)
E. Is the condition of the storage components satisfactory? (NA if no storage) (810.03)
F. Does the system use only AWWA standard D102 approved coating materials? (NA if no applicable storage) (812.33 (3))
G. Is the storage facility(ies) protected from flooding? (NA if no storage) (812.08 (1))
V. Is the distribution system adequate? (NA if no distribution system)

Appendix A- Sanitary Survey Checklist

Non-transient Non-Community Public Water System

Question
A. Are all cross-connections to potential contamination sources eliminated? (810.15)
VI. Is water system operations and management adequate?
A. Are operators up to date with current standards, problem areas in the water system, current issues, new contaminants, regional source water problems, etc.?
B. Have measures been taken to enhance the security of the water supply system? (Recommendations listed in security manual)
C. Have past inspection deficiencies, outlined in previous inspection reports, been corrected as required? (Review / initiate stepped enforcement process)
D. Has the system made an effort to stay in compliance with state regulations?
E. Does the system provide adequate operator support/training? (810.03)
F. Are there adequate long- and short-term plans for system operation and maintenance? (810.13)
G. Does the operator understand: Regulatory costs? Water system budget (annual budget)? Upgrade and maintenance costs for the next 3-5 years?
H. Are adequate public notification procedures adhered to? (809.950)
I. Does the system have adequate revenue to meet regulatory requirements? 810.03
J. Does the system have adequate revenue to cover emergency costs? 810.03
K. Is there a means of communicating with customers other than public notification (annual system newsletter, water conservation pamphlets, etc.)?
VII. Is all monitoring/reporting/data verification adequate and accurate?
A. Has the system been in compliance with their monitoring requirements with respect to samples taken and frequency?
B. Are there updated monitoring plans on file with the department for bacteria (809.31(1)(a)), lead/copper ((809.547(1)(a)) and disinfection byproducts ((809.565(6))?
C. Does the system appropriately implement sampling plans in order to meet monitoring rule requirements? (sample sites spatially appropriate and rotate from site to site)
D. Has the system been in general compliance with regards to water quality?
E. Has water quality generally not degraded since the last sanitary survey?
F. Are monthly operating reports complete and submitted in a timely manner (required for MC's, OTM's that have treatment or chemical addition, all hi-caps)? (810.07)
G. Have the appropriate public notices been issued in a timely manner?
H. Does the monitoring data reported to the DNR match that on file in the system's records? (809.82)
I. Are sampling faucets and faucet locations appropriate for each type of sample (including raw, entry point and distribution)?
J. Is the sampling procedure for each type of sample appropriate?
K. Were there no recent water quality and/or quantity complaints from customers?
VIII. Has the operator(s) fulfilled certification requirements?
A. Does the system have a certified operator? (810.04(3))
B. Has the operator(s) fulfilled continuing education requirements? (NR 114 Subchapter I or III)
C. Is the operator(s) aware of renewal requirements and certification expiration date?

Appendix B-
Geological Sections of WI Aquifers

Appendix B- Geological Sections of WI Aquifers

System	Formation	Materials	Thickness	Water-bearing capability	Area of Wisconsin
Quaternary	Recent alluvium	Sand, gravel, peat, muck, marl	0'-100'	Small to large yields from sand and gravel regions	Majority of state except for west-southwestern
	Pleistocene deposits	Boulder, clay, silt, sand, gravel	0'-500'		
Devonian	Milwaukee and Theinsville	Dolomite, shale and limestone	50'-100'	Small	Eastern Lake Michigan coast
Silurian	Waubeka and Niagara	Dolomite	300'-825'	Small to moderate	
Ordovician	Maquoketa shale	Dolomite shale	50'-540'	Small	
	Galena dolomite Decorah shale Platteville	Dolomite Shale Limestone	200'-350'		Eastern, western and south central areas of state
	St. Peter	Sandstone	0'-330'	Small to moderate	
	Prairie du Chein	Dolomite	0'-200'		
Cambrian	Trempealeau Franconia Dresbach Eau Claire Mount Simon	Sandstone	0'-1,000'	Small to large	
Precambrian	Lake Superior	Sandstone, shale, basalt	Varies	Small	Northwestern
	Basement complex	Crystalline bedrock			Entire state