2 WATER SYSTEM INSPECTIONS

2.1 General

2.1.1 Responsibilities (1/12/11)

Regional DG WS Specialists and Engineers – Conduct all inspections, maintain records of inspections, enter data on DWS related to sanitary surveys, provide data to EnPAs for updating DWS on regulatory related information.
Regional DG Supervisors – Monitor frequency of sanitary surveys and annual inspections within the Region to ensure staff are meeting DGMT assigned time frames.
Review surveys for completeness and quality. As part of DGMT set standards for inspections.
Regional EnPAs – Enter data on regulatory related information into DWS. Assist Regional DG Supervisors tracking survey frequencies.
Central Office Plan Review Staff – Provide assistance to Regional DG Staff on inspection of complex water treatment systems. The surface water engineer should be contacted to accompany Regional DG staff on all sanitary surveys at surface water systems.
Public Water Supply Section Chief - Monitor frequency of sanitary surveys and annual inspections statewide to ensure staff are meeting DGMT assigned time frames. As part of DGMT set standards for inspections to ensure consistency and quality.

2.2 Sanitary Surveys

2.2.1 General (1/12/11)

Sanitary surveys of water systems are essential to assuring safe drinking water on a continuing basis. These surveys serve as a mechanism to detect construction, location, maintenance, and operational deficiencies before an unsafe water condition occurs. In cases where unsafe water occurs, the sanitary survey is used to isolate the problem so that corrections can be made. By conducting surveys on a recurring cycle, new construction can be checked for conformance with approvals and any deterioration of facilities can be detected. Sanitary surveys are routinely performed at all public water systems.

“Sanitary survey” means an on-site inspection of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of the source, facilities, equipment, operation and maintenance for producing and distributing safe drinking water” NR 809.04(72).

2.2.1(a) Federal Rules (GWR & IESWTR) (2/23/11)

Two rules provide the principal federal requirements for sanitary surveys.

- **Interim Enhanced Surface Water Treatment Rule (IESWTR)**

The IESWTR (66 Federal Register 3769, effective date February 15, 2001) requires that states conduct sanitary surveys of surface water and Groundwater Under the Direct Influence of surface water (GWUDI) systems every 3 years for Community Water Systems (CWS’s) and every 5 years for Non-community Water Systems (NCWS’s). CWS’s that are “outstanding

performers" can have surveys done every 5 years. Surveys must examine the required eight elements, and PWS's must correct significant deficiencies. PWS's also must indicate within 45 days, how and when they are going to do so.

- **Groundwater Rule (GWR)**

The GWR (71 FR 65574, November 8, 2006, Vol. 71, No. 216 Correction 71 FR 67427, November 21, 2006, Vol. 71, No. 224) applies to all public water systems serving groundwater. It doesn't apply to systems serving surface water, mixing all their groundwater with surface water, or with GWUDI systems. Under the GWR, sanitary surveys must address the minimum eight elements and must be conducted every 3 years for CWS's and every 5 years for NCWS's. CWS's that are "outstanding performers" can have surveys done every 5 years. The GWR requires that systems with significant deficiencies identified during sanitary surveys, or during other State activities, must correct significant deficiencies within 120 days or be in compliance with a State-approved plan and schedule for correction. Failure to correct significant deficiencies on time results in a treatment technique violation. (See 2.2.1(e))

2.2.1(b) Authority & Responsibilities (Statutes & Administrative Codes) (1/12/11)

Wisconsin Statute ch. 280 gives DNR the authority to write and enforce standards and rules. Section 280.13(1)(c), Wis. Stats., gives the department the authority to enter and inspect wells and equipment. It also gives the department the authority to order necessary corrections.

The requirements for sanitary surveys are promulgated in NR 809, as follows:

- s. NR 809.35 Scope and frequency
- s. NR 809.32(3)(2) Requirement to correct significant deficiencies
- s. NR 809.327 Compliance with a state approved corrective action plan and schedule
- s. NR 809.328 Treatment technique compliance

2.2.1(c) Scope (1/12/11)

The scope of all sanitary surveys should encompass the eight basic elements:
1. source
2. treatment
3. distribution system
4. finished water storage
5. pumps & pumping facilities
6. monitoring and reporting
7. water system management and operations
8. operator certification

The level of detail of the survey may vary based on the complexity of the water system.

2.2.1(d) Frequency (2/23/11)

The frequency of sanitary surveys for both groundwater systems (as required by the GWR) and surface water systems (as required by the IESWTR) are the same.

- **Community Water Systems.** Community water systems are required by the SDWA to have sanitary surveys at least once every 3 years. Systems determined to be "outstanding performers" may receive surveys on a 5 year frequency. To designate a water system as an outstanding performer the system must meet the requirements outlined in section 2.2.12. Designation as an outstanding performer requires concurrence by the Regional DG Supervisor.

- **Non-Community Water Systems.** Non-community water systems are required by the SDWA to have sanitary surveys at least once every 5 years.

2.2.1(e) Compliance Schedule (5/21/13)

The DNR developed the below steps for sanitary surveys conducted in Wisconsin in order to be in compliance with the GWR requirements.

1. Inspectors have 30 days from the date of the inspection to complete and send the sanitary survey (SS) letter to the PWS. This letter serves as a notice of deficiencies and a state approved corrective action plan and schedule (CAP). County inspectors should consult their DNR Rep, and DNR inspectors should consult their supervisors before issuing any corrective action due dates for **significant** deficiencies greater than one year.[1]

2. If any deficiencies are identified, the PWS has a **maximum** of 45 days from the date of the SS letter to respond to the inspector with notification of one of the following:

   a. All deficiencies have been corrected,
   b. Or, they will comply with the CAP specified in the SS letter,
   c. Or, they will comply with a proposed new CAP, which includes specific dates for correcting the deficiencies.

   The 45 day response time is only the maximum. Deficiencies with quicker corrective action due dates will require earlier response due dates.

3. If the PWS's response includes new proposed dates to correct **significant** deficiencies that are later than 120 days from the SS letter, <u>inspectors must provide a concurrence letter to the PWS.</u>

4. If a PWS fails to respond to the SS letter before the response due date and has **significant** deficiencies, inspectors **may** make an enforcement request for a Notice of Violation (NOV) and enforcement conference to environmental enforcement.[2] County staff should work with DNR on these. The NOV shall:

   a. Be sent as soon as possible after the response due date has passed,
   b. Reiterate the deficiencies and code citations, and
   c. Note that they have 120 days from the date of the SS inspection letter to be in compliance or additional enforcement may occur.

5. Requests for extensions can be granted at any time during the 120 day period following the assessment letter date. If the system has not renegotiated the CAP and the compliance date is approaching, the inspector may choose to contact the system prior to the compliance date. If the system requests renegotiation of the CAP before the compliance due date or within 120 days from the date of the assessment letter, whichever comes first, the inspector may extend the deadline for up to one year *without Environmental Enforcement involvement*

6. If the PWS fails to agree with the department on a CAP within 120 days, a Treatment Technique Violation (TTV) is issued and inspectors **must** submit an enforcement request form for an NOV, enforcement conference, and a consent order or compliance agreement.[3]

7. Failure to comply with the required CAP for **significant** deficiencies will result in a TTV (NR 809.328(a)(1). An enforcement conference is required if the system has not already returned to compliance. TTV's (as specified in the Ground Water Rule) are subject to Tier 2 public notification. There are also special public notice requirements for GW systems that fail to correct significant deficiencies. Non-community systems must provide special public notice, in a manner approved by the Department, for any significant deficiency that is not corrected within twelve months. NR 809.950(3)(a)2.

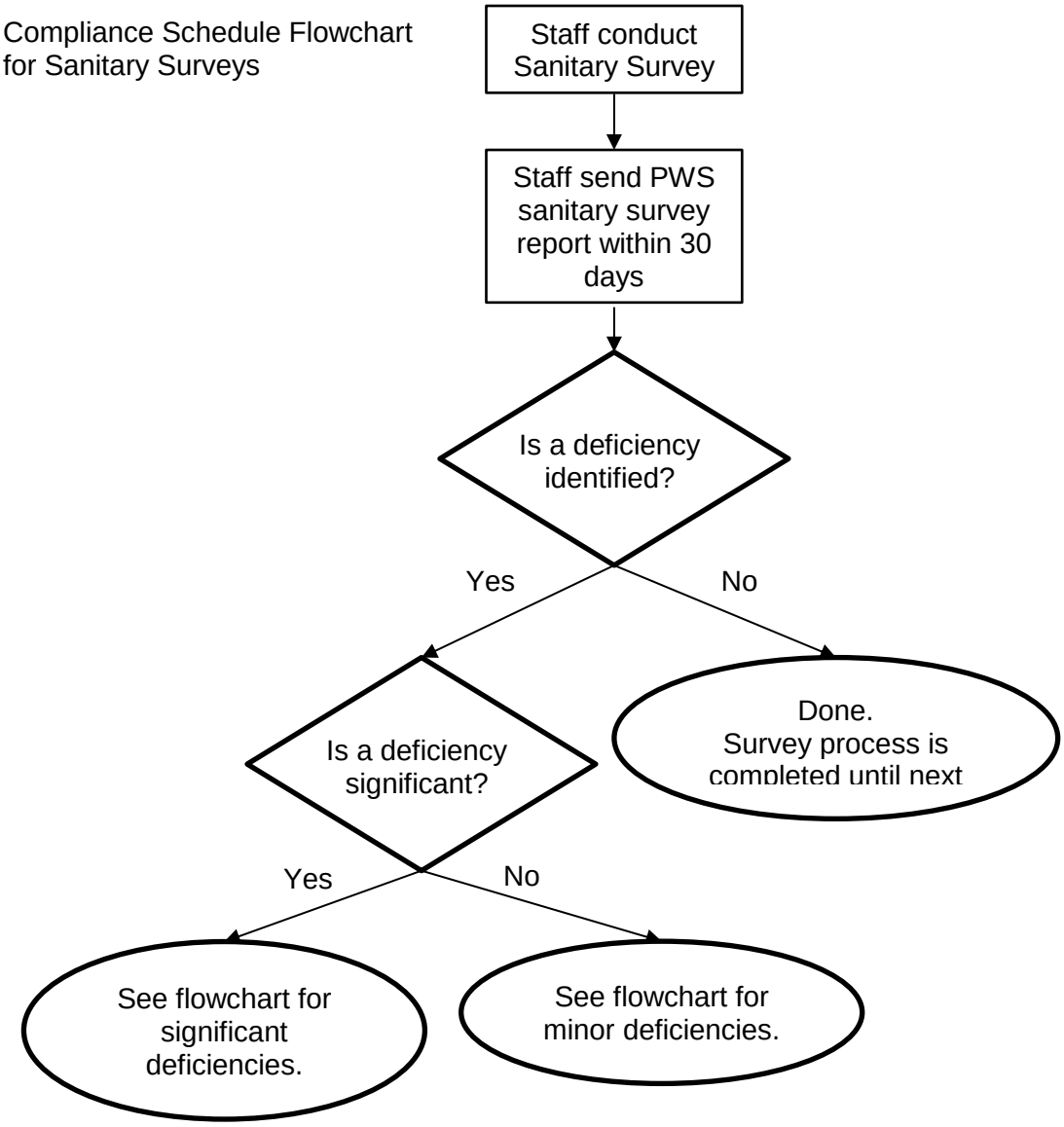
8. After completion of corrective actions, the PWS has 30 days to notify the inspector in writing that **significant** deficiencies have been corrected. This can be via email, or signed Corrective Actions Verification form. Failure to provide this notification within 30 days results in a failure to notify violation

[1] For those systems with CAPs that will extend past one year, the inspector **may** forward an enforcement request form for an NOV and Enforcement Conference to EE. The inspector and enforcement specialist will determine the appropriate enforcement tool to utilize after the enforcement conference.

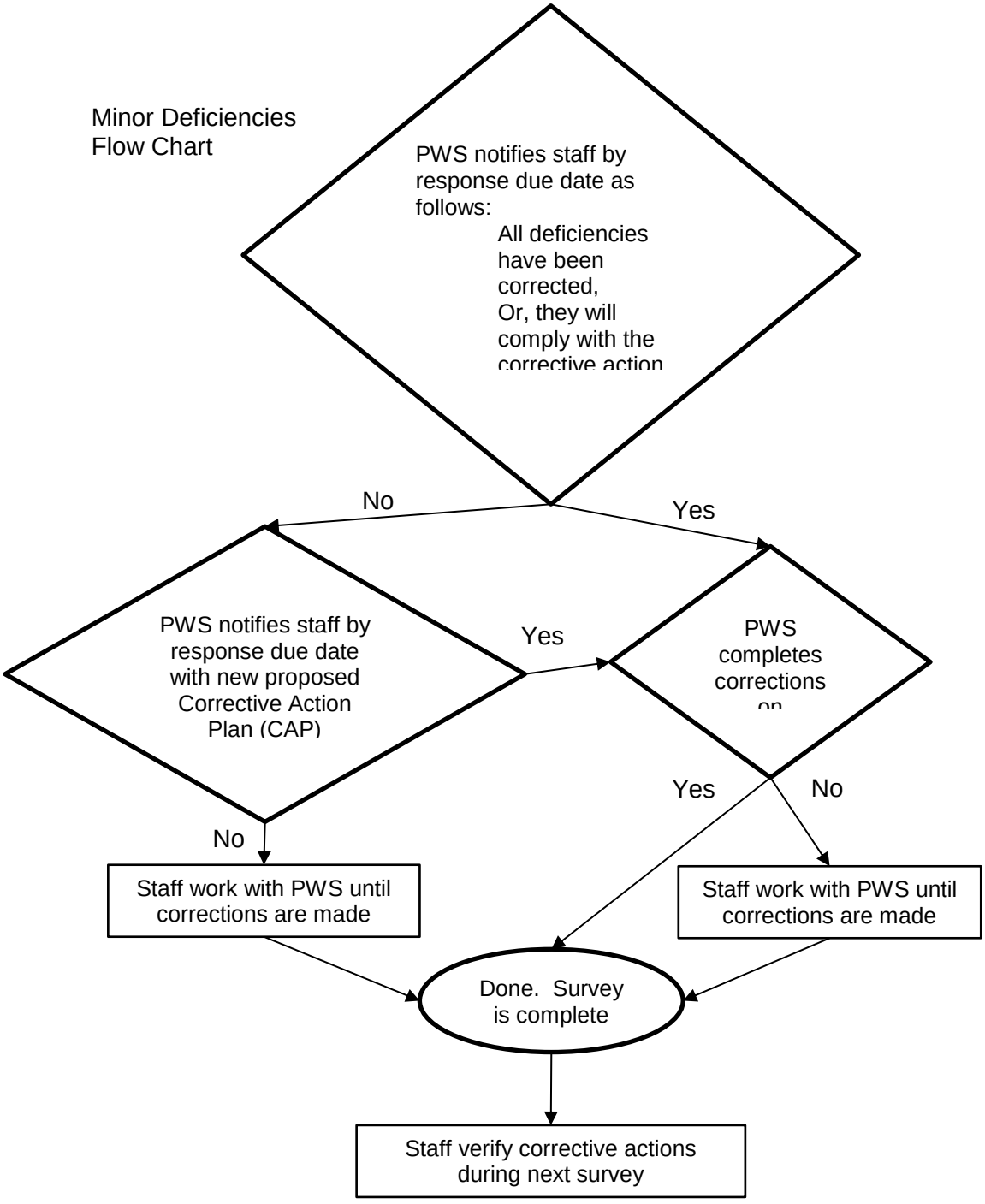
[2] An NOV can be issued at any time after the survey. It is not the same thing as a TTV. Considerable professional judgment is allowed for when to issue NOVs. Systems that seem unlikely to correct deficiencies in a timely manner should receive NOVs with an enforcement conference request early on in the process. Systems that seem very likely to correct deficiencies quickly may never need an NOV at all.

[3] When a TTV occurs, county staff should work with DNR to draft enforcement request forms. DNR Environmental Enforcement staff create TTV letters and schedule enforcement conferences.

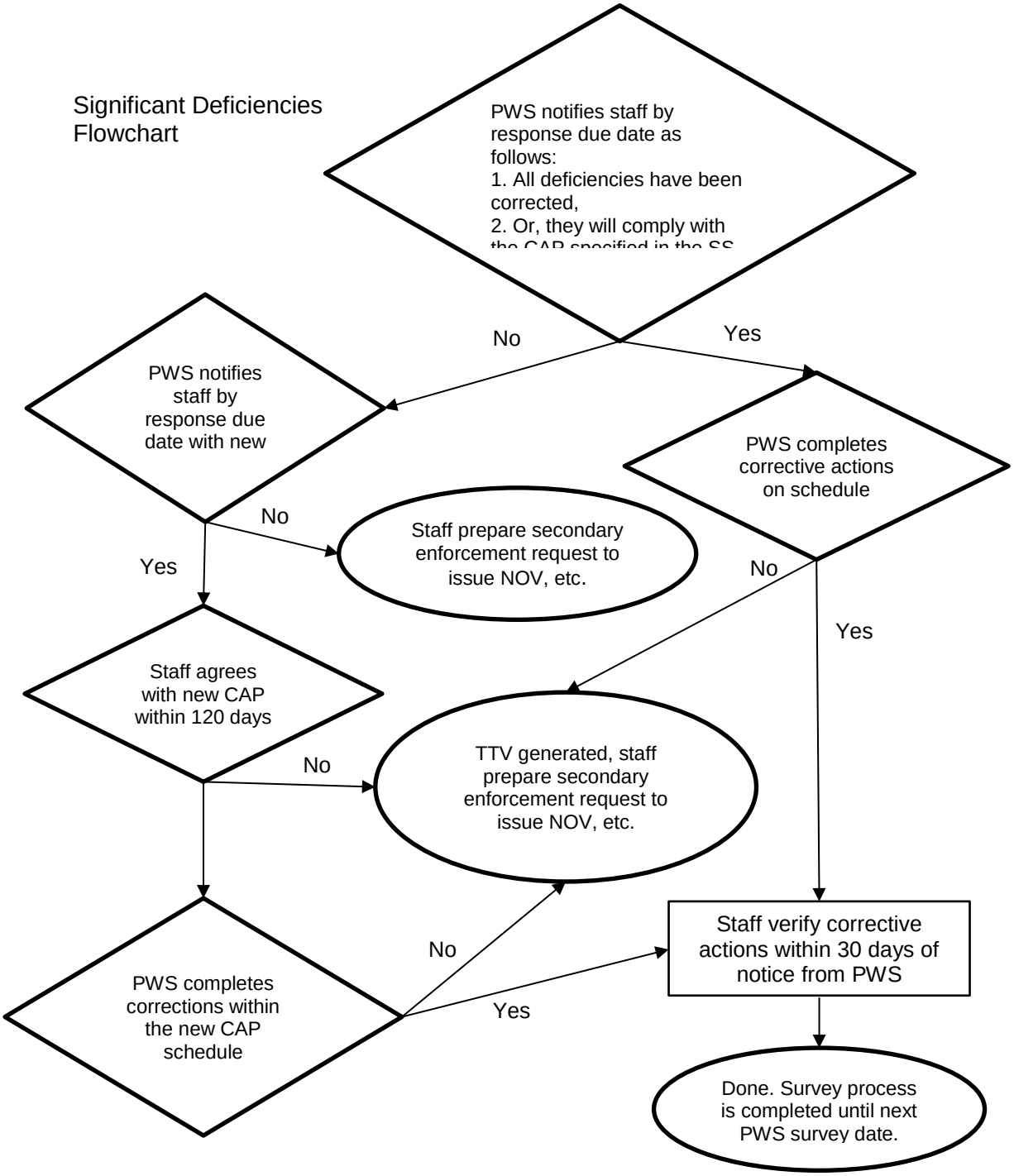
Compliance Schedule Flowchart for Sanitary Surveys



Minor Deficiencies
Flow Chart



Significant Deficiencies Flowchart



2.2.2 Deficiency Severity (1/12/2011)

2.2.2(a) Definitions

Significant Deficiencies indicate noncompliance with one or more Wisconsin Administrative Codes and/or represent an immediate health risk to consumers.

“Significant deficiency" includes, but is not limited to, defects in design, operation, or maintenance of a public water system, or a failure or malfunction of the water sources, treatment, storage or distribution system of a public water system that the department determines to be causing the introduction of contamination into the water delivered to consumers or when the department determines that a health risk exists to consumers of the water. NR 809.04(72)

Deficiencies (minor) are problems in the drinking water system that have the potential to cause serious health risks or represent long-term health risks to consumers. These deficiencies may indicate noncompliance with one or more Wisconsin Administrative Codes.

Recommendations are problems in the water system that hinder a public water system from consistently providing safe drinking water to consumers.

Default Significant Deficiencies - In accordance with the GWR, at least one deficiency has been identified under each of the eight elements that is considered significant. This means that this deficiency should be significant in almost all cases. It does not circumvent the professional judgment of staff however, and can be given a lower level of severity if the inspector determines it is appropriate in certain instances.

2.2.2(b) Recommended Severities by System Type

Workgroups of DNR specialists and engineers developed recommended severities for deficiencies or potential problems observed during sanitary surveys. The results are posted on the central file service in the folder DG_Projects\PE_Sanitary_Survey\References.

2.2.2(c) Default Significant Deficiencies by System Type

Workgroups of DNR specialists and engineers developed default significant deficiencies. These are located on the common drive in the “sanitary survey folder” in a file called, “Deficiency Recommendations all System Types.”

2.2.2(d) Non-conforming Features

System features that met code requirements at the time of a water system’s construction, but would not be allowed in the current version of the code are called non-conforming features. These are technically not deficiencies, however they should be noted in the survey as they will need to be corrected when the system completes any major upgrades in the future. These should be included in the assessment letter as recommendations.

Example: OTMs with pitless adapters were allowed pre-78. We now require pitless units or top discharge.

2.2.3 DWS Sanitary Survey Screen (1/12/11)

The DWS contains basic system data on water quality, construction, water treatment, storage, operator certification, violations, and deficiencies. Regional DG staff are responsible for maintaining and updating the data. Sanitary survey screens within the DWS should be referenced as part of the pre-survey evaluation, and must be used for documentation of the survey, listing and tracking violations and deficiencies, and preparing the sanitary survey report.. All field staff are expected to use the DWS sanitary survey checklist, document survey findings and corrective actions/schedules in DWS and rely on DWS to generate their survey report/assessment letter.

2.2.3(a) Data Tables

All the fields with a grey background are protected against update by staff. In most instances EnPAs **do** have permission to update this information; however they generally do so from other screens in the DWS. EnPAs may also be required to delete accidental entries. DNR REPs have permission to update the information in **some** of the tables.

The tables are generally set up to accept certain kinds of data (text, numeric, dates, or a selection from a list of values) and will not allow non-standard entries. To access the list of values for a particular field hit the blue arrow button at the top of the page. The F9 key will also display the list of values. Not all fields have this option.

It is often necessary to insert a new line into a table. To do this hit the insert button at the top of the screen.

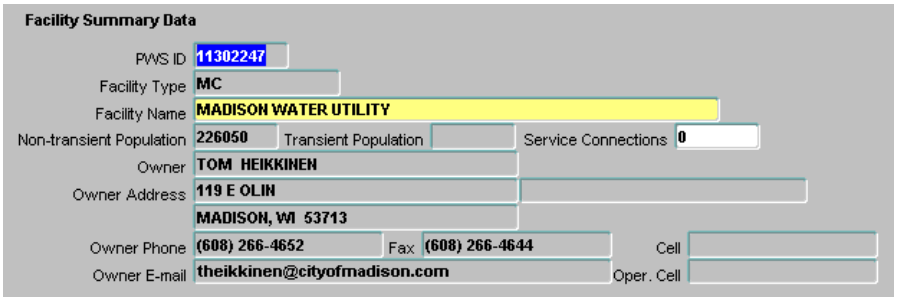
Some tables will not let you continue until you hit save.

Some, but not all, tables will allow you to delete records (entire lines in a table). This can be done using the delete button.

The undo button deletes or re-enters data from a single field only if your cursor is in that field and you just altered that field without saving.

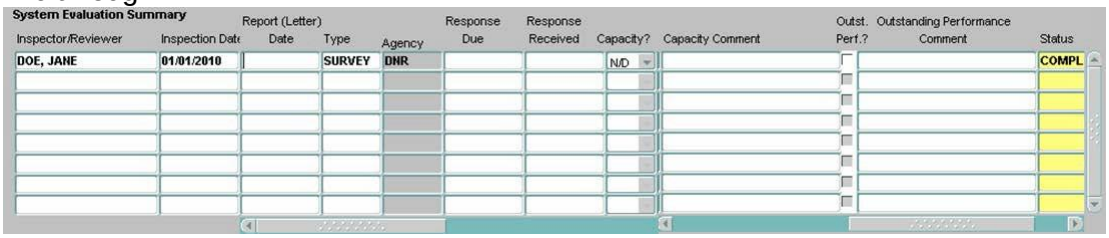
<u>Facility Summary Data</u>
This is the specific identifying information about the system (name, address, PWS ID). This table also includes the number of people served, which should be updated during sanitary surveys. Most of the fields in this table are protected against update and must be completed by a PA.

Facility Summary Data (continued)



System Evaluation Summary

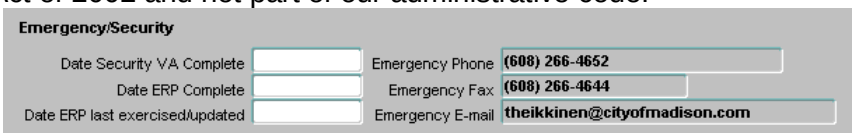
This table displays the dates and types of inspections that have been performed at the system, as well as the capacity status. Inspectors should use the blue arrow located on the top tool bar, or the F9 key to find their name in the list of values. This will ensure that their name is formatted consistently. For more detail on the other fields in this table see 2.2.6 through 2.2.12.



Emergency/Security

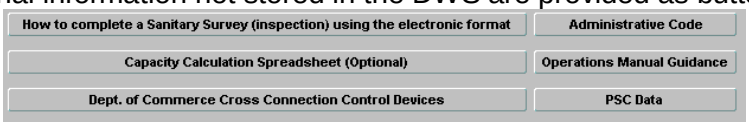
All community systems must have an updated emergency operations plan in place to prepare for, respond to, mitigate and recover from all types of emergency situations, including terrorism, sabotage, natural disasters such as floods and tornadoes, loss of system-wide pressure, and overfeed of chemicals. This is not a requirement for non- community systems. NR 810.26(8).

Municipal systems had to complete a security vulnerability assessment in 2003 or 2004 (depending upon system size). This was a requirement of the Bioterrorism Preparedness and Response Act of 2002 and not part of our administrative code.



Links

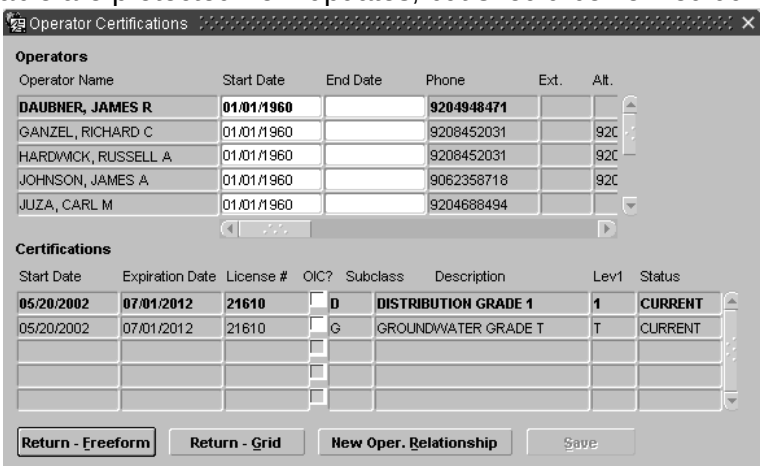
Links to additional information not stored in the DWS are provided as buttons here.



The DCOMM link will be changed to the DSPS link below.
http://apps.commerce.state.wi.us/SB_ServiceAgent/SB_RegObjMain.jsp?o2=8&Submit3=Go+to+detailed+search

Certified Operators

This table includes information about the current certified operators associated with the system. It gets pulled in from the Environmental Licensing and Certification (ELC) system. All the fields in this table are protected from updates, but should be verified during surveys.



The Operator-In-Charge (OIC) should be designated for all required subclasses. Inspectors should contact staff in ELC to enter this information.

Affiliations

This table includes the contact information for people associated with the system. The fields in this table are protected from update, but should be verified during surveys. Any updates must be made by EnPAs.

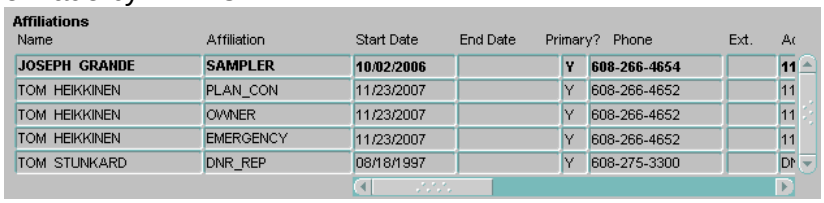


Table too big to show in its entirety Entry

Points and Sources of Water

This table has relevant data on the well/source & pump.

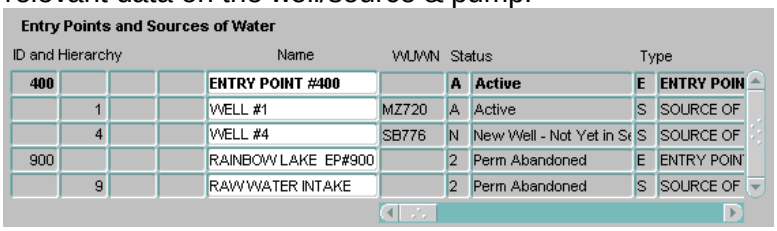


Table too big to show in its entirety

- ID and Hierarchy – (protected fields) Individual sources (wells/intakes) and entry points from individual sources are numbered 1-99 (80's are reserved for surface water plant entry points, 90's are reserved for reconstructed wells), and combined entry points are numbered 100, 200, etc. It is important to only assign combined entry points where you know for sure that

the water at the physical entry point comes from more than one source and that the water quality is consistently a mix. This is critical because routine monitoring occurs at this point and if the water being sampled is really only coming from one source, then the water quality from the other sources that contribute to this combined entry point isn't being properly monitored. In general, the Sources of Water directly below the Entry Points are the contributing sources.

- Name – An identifying name to go with the ID number. These names show up as the title of each monthly report page. For this reason, do not use addresses and for entry points that have more than one source, include a name that identifies the purpose (treatment) and which wells contribute.
- WUWN – Wisconsin Unique Well Number
- Status – Active, Inactive, Not yet in service, Temporarily abandoned, Permanently abandoned, Temporarily out of service, Reconstructed well
- Availability (this shows up only on the EP/S screen, not on the table in the SS screen) – Permanent, Emergency, Interim, Other , Seasonal
- Type – Entry Point/Source combined, Entry Point only, Source but not an entry point
- Water Source
- Depth – Total depth of the well (feet). Must be obtained from well construction report
- Water Bearing Formation – This should be obtained from the well construction report
- Well Location Coordinates (Township, Range, Dir, QQ, Lat, Long)
- Pump Capacity – Gallons per minute
- Pump Type – Submersible, Vertical Turbine, Centrifugal, Hand Pump, Jet Pump/Shallow Well, Jet Pump/Deep Well, Jet Pump/Packer Jet, Other
- Pump Make
- Pump HP – must be displayed in non-fraction number, i.e. 0.5 HP
- Pump Lube Type – Oil, or Water?
- Above Ground Discharge or Pitless Adapter?
- Aux Power – Yes or no?
- Casing Height – The height of the casing above grade (inches)
- Casing Size – Width (inches)
- Cased Depth – Feet
- Cap/Seal Type – Split Seal, Full plate sanitary seal, Overlapping, Vermin Proof, Turbine/Hand Pump base, Morrison Head Cap, Threaded Sanitary Seal
- Grouted Depth – Should be obtained from the grout depth on the WCR
- Variance? – Yes or no.

<u>Storage</u>

Storage

ID/Location	Type	Volume (gal)	Firm Pumping Capacity (gpm)	Height to Overflow (ft.)	Overflow Elevation (sea-level, ft.)	Aux Pow
@ well #3	Ground Storage	**40000**	**1800**			No
@ well #5	Ground Storage	250000	1500			Unknown
@ well #6	Ground Storage	155000	2100			Unknown
@ well #7	Ground Storage	160000	2150			Unknown
@ well #8	Ground Storage	140000	1550			Unknown

Table too big to show in its entirety

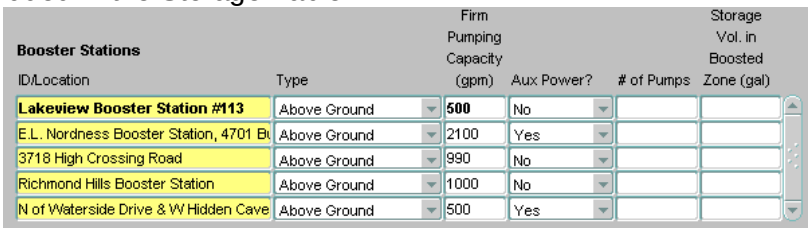
- ID/Location – This is a unique description of the storage location. These names show up as the title of each monthly report page where treatment occurs. For this reason, do not use addresses and use a name that clearly identifies the reservoir. For example, Tower at

Well 3, Reservoir at Well 3, Standpipe on Main, North Clearwell, 9 MG CT tank.

- If multiple tanks are located in the same place, ID numbers help distinguish them beyond simply their location, i.e., 01/wellhouse & 02/wellhouse. ID numbers are not otherwise necessary.
- Type – Pressure Tank, Elevated Tank, Stand Pipe, Ground Storage
- Volume – in gallons
- Firm Pumping Capacity – This is only applicable to reservoirs and standpipes. The pumping capacity when the largest pump is out of service. The need for pumping capacity capable of meeting peak demands declines as storage increases. Hence the two go together.
- Height to Overflow – The height from the ground surface of the overflow pipe (in feet). The drain piping shall be within 12 to 24 inches of the ground surface, with a free air break over a drainage inlet structure, splash pad, or riprap. NR 811.64.
- Overflow Elevation – The elevation above sea level of the overflow pipe
- Auxiliary Power – Required at all municipal systems, NR 811.27.
- Date of Last Interior Inspection, NR 810.14.
- Manufacturer
- Model

Booster Stations

These are not common in non-community systems. This table is for in-line booster stations only. Details for booster pumps associated with a ground storage reservoir should be included in the Storage Table.



Booster Stations

ID/Location	Type	Firm Pumping Capacity (gpm)	Aux Power?	# of Pumps	Storage Vol. in Boosted Zone (gal)
Lakeview Booster Station #113	Above Ground	**500**	No		
E.L. Nordness Booster Station, 4701 Bu	Above Ground	2100	Yes		
3718 High Crossing Road	Above Ground	990	No		
Richmond Hills Booster Station	Above Ground	1000	No		
N of Waterside Drive & W Hidden Cave	Above Ground	500	Yes		

- ID/Location - This is a unique description of the booster. Do not use address, but use a name that clearly identifies the booster station. For example, NE Booster Station, Booster a High Crossing Rd.
- Type – Above ground, buried
- Firm Pumping Capacity
- Aux Power?
- # of Pumps
- Storage volume in Boosted Zone

System Interconnects

This table displays information about locations where the system is interconnected with another public water system. These types of interconnections always require an approval (NR 810.15(2)).

System Interconnects (continued)

System Interconnects

ID/Location	Type	Capacity (gpm)	Metered?	Chemical Injection Capable?
AIRPORT DRIVE	Buried		Yes	No
MAIN STREET	Buried		Yes	No
QUINCY	Buried		Yes	No

Treatment Summary Data

This table displays the various treatment systems being operated at the PWS. Staff inspect and verify that these systems are operating according to approval conditions, if approval was required. Staff must also document all treatment devices being operated that do not require formal approval (softeners, particulate filters, etc.). There is a comment field to the far right that can be used to make notes about odd treatment or the purpose of the treatment that goes beyond what the objective code offers. The comment field should also be used to differentiate between citation and anion exchange when selecting Ion Exchange as the treatment. The treatment code 999 should be used for treatment like blending or adsorptive media for arsenic treatment.

Treatment Summary Data

Source ID	Treatment Type		Flow %	Begin Date	End Date	Approval Date	Pump Model	Capacity (GPD)
1	**380**	**Fluoridation**	**100**	**01/01/1960**	**11/30/1987**			
2	380	Fluoridation	100	01/01/1960	11/23/1992			
3	380	Fluoridation	100	01/01/1960				
3	421	Hypochlorination, Post	100	01/01/1960				
4	380	Fluoridation	100	01/01/1960	11/01/1992			
5	380	Fluoridation	100	01/01/1960				
5	421	Hypochlorination, Post	100	01/01/1960				
6	380	Fluoridation	100	01/01/1960				

Table too big to show in its entirety

If two or more wells use the same physical treatment plant and chemical feed pumps, the treatment codes must be entered under each source. For instance, two wells pump into a common pipe and then into the distribution system. The wells never run at the same time and there is only one chlorine pump. The chlorine pump runs when either one of the wells kicks on or when flow is detected.

When wells are abandoned, end dates must be entered under all treatment affiliated with the well.

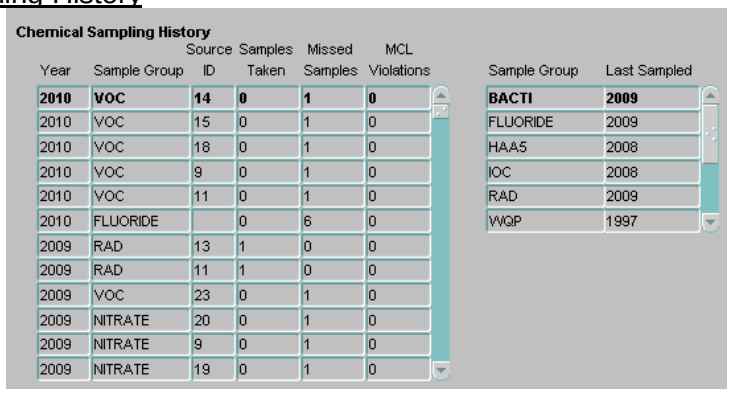
Bacteriological Sampling History

The most recent six years of bacteria monitoring data are displayed in this table.

Bacteriological Sampling History

Year	Distribution Safe	Distribution Unsafe	Confirmed Unsafe	Missed Samples	Raw Safe	Raw Unsafe
2010				**450**		
2009	1,511	2		1,023	53	
2008	2,828			0	95	1
2007	2,648	1		0	102	
2006	2,428		2	0	93	
2005	2,567	2		0	82	2

Chemical Sampling History

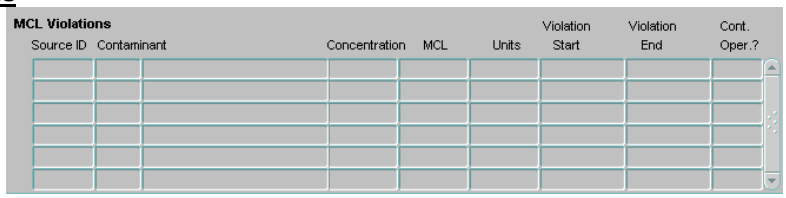


Chemical Sampling History

Year	Sample Group	Source ID	Samples Taken	Missed Samples	MCL Violations
2010	**VOC**	**14**	**0**	**1**	**0**
2010	VOC	15	0	1	0
2010	VOC	18	0	1	0
2010	VOC	9	0	1	0
2010	VOC	11	0	1	0
2010	FLUORIDE		0	6	0
2009	RAD	13	1	0	0
2009	RAD	11	1	0	0
2009	VOC	23	0	1	0
2009	NITRATE	20	0	1	0
2009	NITRATE	9	0	1	0
2009	NITRATE	19	0	1	0

Sample Group	Last Sampled
BACTI	**2009**
FLUORIDE	2009
HAA5	2008
IOC	2008
RAD	2009
VVQP	1997

MCL Violations



MCL Violations

Source ID	Contaminant	Concentration	MCL	Units	Violation Start	Violation End	Cont. Oper.?

2.2.3(b) Reports

In addition to the data tables displayed on the sanitary survey screen there are also reports that must be accessed for sanitary surveys. Buttons to pull up the Pre-survey Report and the Assessment Report (Assessment Letter) are located under the System Evaluation Summary table on the sanitary survey screen. For more detailed information on these reports see 2.2.5 and 2.2.13, respectively.

2.2.3(c) Checklist

The “Survey checklist for selected inspection” button pulls up the same list of questions that appear on the Pre-survey report. If using the Mobile Sanitary Survey system these questions will automatically be completed upon synching the MS^3 with the DWS. If not using the MS^3 inspectors will need to complete these questions manually using the answers given on the Pre-Survey report. All questions default to “yes” so inspectors will only need to change the answer for questions where a “no” or an “N/A” is necessary.

2.2.3(d) Deficiencies for Selected Inspection

Any question checked “no” on the electronic “Survey checklist for selected inspection” will automatically result in a deficiency being assigned to the PWS. The default level of severity is set at “significant.” To assign a different level of severity for a deficiency, inspectors must enter the “Deficiencies for selected inspections” table and chose the appropriate severity from the list of options. Information from this table will also appear in the “Assessment report for selected inspection.” When a deficiency is noted that was not covered by the checklist, inspectors can add a deficiency to the table by simply placing the cursor in an open cell under the “Description” heading.

This table also includes the following fields:

- Description of the problem that needs correcting
- Priority – This will sort the deficiencies on the assessment letter by order of importance
- Code Citation No.
- Sanitary Survey Section – Select one of the eight elements
- Compliance Due – The date when items must be corrected
- Compliance Achieved – The date the system gives for when corrections were made
- Actions Taken – What the system did to correct the problem
- Observations
- Location Description

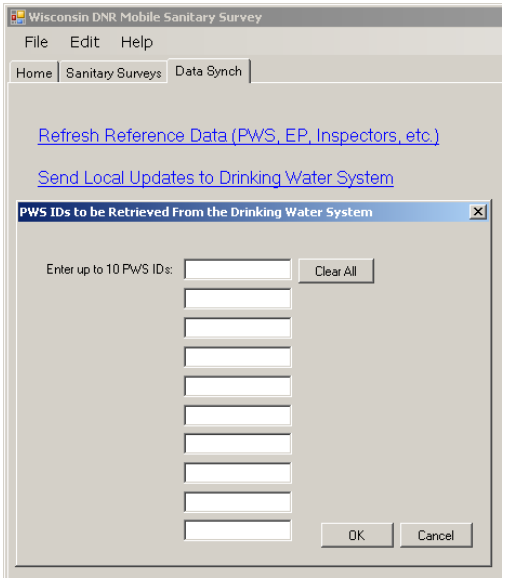
Inspectors also have the option of adding additional deficiencies to this table for issues that are not captured in the checklist.

2.2.4 Mobile Sanitary Survey System (MS^3) (1/12/11)

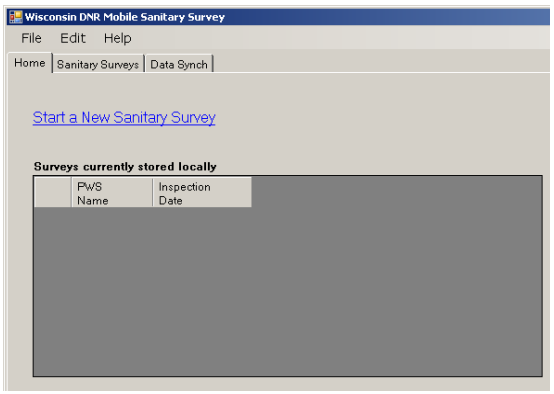
The MS^3 is a streamlined mobile version of the sanitary survey page. Its main function is to provide a tool to electronically capture sanitary survey data in the field and upload this data to the DWS. It does not contain, nor should it contain, all of the information found on the DWS. It can not be used to generate reports, review monitoring results, violations, etc. It is designed for use with tablet PCs in the field, though it can be used on a laptop or desktop pc too.

Navigating the MS^3

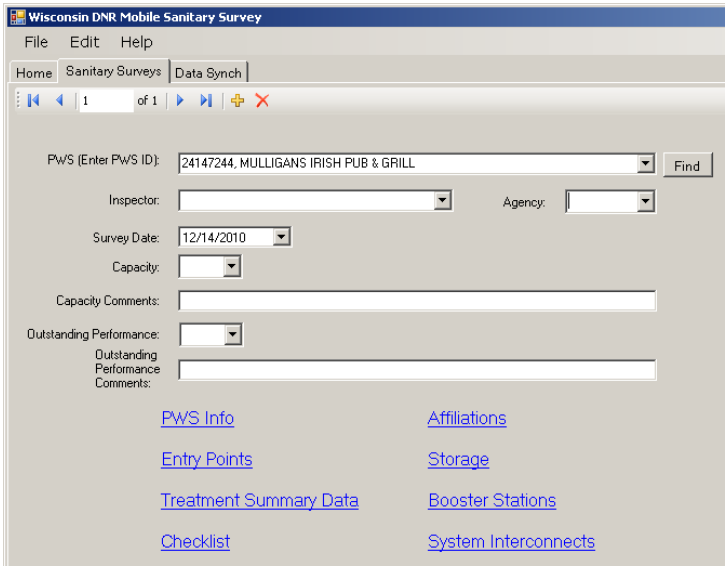
When you open the MS^3 go to the Data Synch tab and select "Refresh Reference Data (PWS, EP, Inspectors, Etc.)." Then type in up-to ten PWS IDs that you will be doing surveys on, and hit "ok." This will upload the data from the DWS for these selected systems into your MS^3. This data is now available to you in the field without the need to be connected to the DWS.



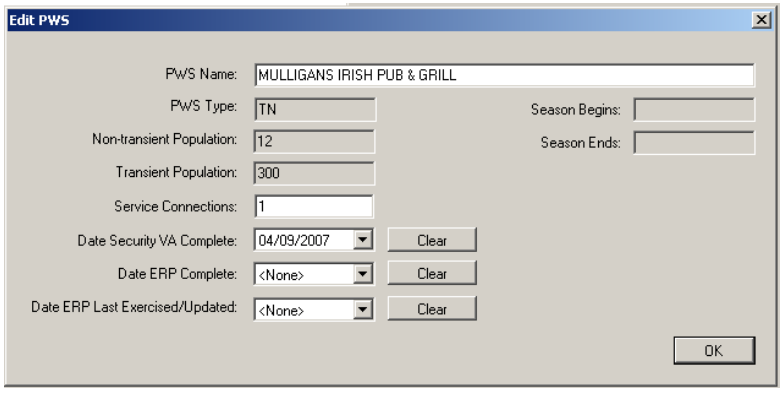
Next select the "Start a New Sanitary Survey" tab.



In the sanitary surveys tab choose the system you wish to work on from the list of systems uploaded.

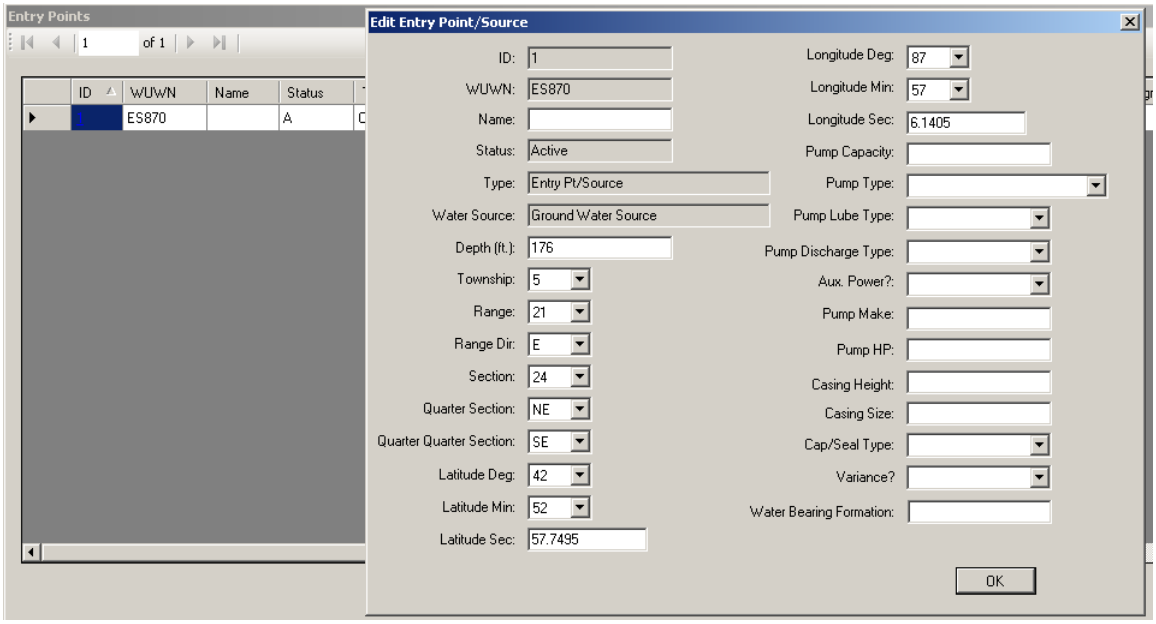


Select the “PWS Info” table and verify/add information. Fields that are gray must be updated by EnPAs.



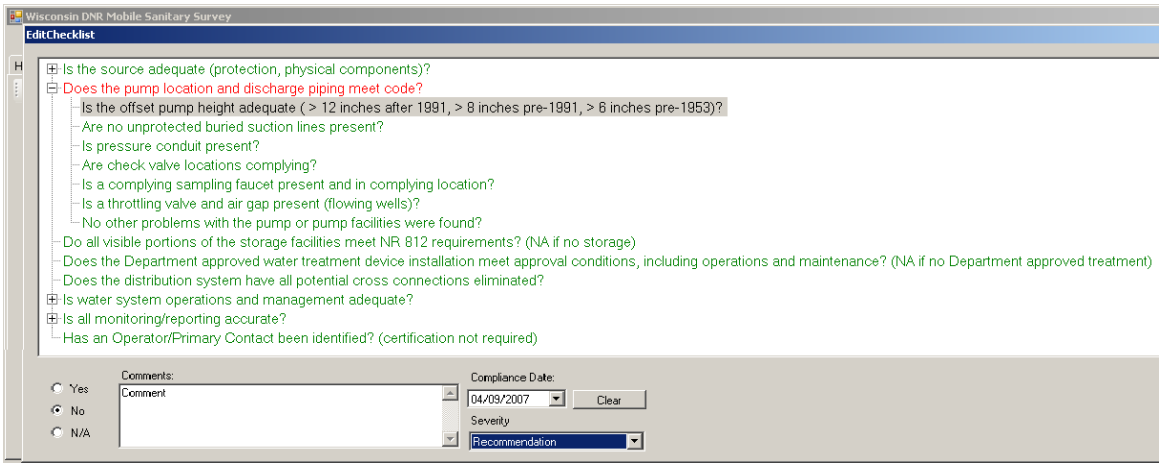
Next select the “Entry Points” table. A table will open that is very similar to what is displayed in the DWS. To edit the information in this table, click on the blue ID field. This will cause the “Edit

Entry Point/Source” table to open. Use the drop downs and text boxes to edit the information in this table.

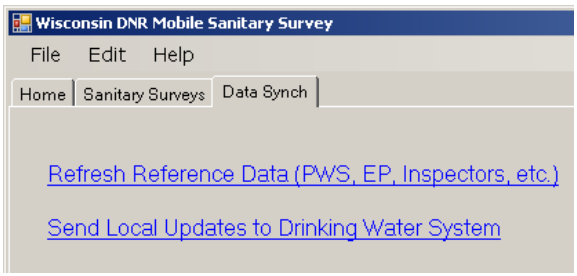


The “Treatment Summary Data,” “Affiliations,” “Storage,” “Booster Stations,” and “System Interconnects” tables can be edited in the same manner as the “Entry Points” table.

The “Checklist” table also looks very much like the “checklist for selected inspection” table on the DWS. The default for questions is “yes.” Selecting “no” will change the color of the question from green to red. Selecting “N/A” will turn the question black. Use the “Comment,” “Compliance Date,” and “Severity” fields for any question marked “no.”



Data obtained during a sanitary survey can then be directly uploaded to the DWS. This is done by going to the “Data Synch” tab and selecting “Send Local Updates to Drinking Water System.” Once the survey data is sent to the DWS, it is automatically removed from the tablet/laptop.



2.2.5 Pre-Survey Evaluation (4/2/12)

2.2.5(a) File Review

Prior to inspecting a water supply all records pertaining to that system should be reviewed. The correspondence file should be read; past violations (including non- grouted wells), complaints, plan approvals and any modifications since the last survey should be noted. The operator's certification should be verified to assure the proper grade certification for the system being operated. Pumpage and sampling reports should be checked for completeness and accuracy. Minimum sampling requirements should be verified and the sampling record checked. The scheduling for a chemical, organic or radiological analysis should be reviewed to determine if sampling should be conducted at the time of the inspection. The date of the last interior storage tank inspection should also be noted. This information is summarized on the sanitary survey screens in the DWS. Where appropriate, a review of distribution system maps for: appropriateness of dead ends, number of river and highway crossings, possible "flow through" situations (MHPs, condos, gated communities, etc.) should be completed. Additionally, inspectors of municipal systems should review the fluoride screen on the DWS and the most current PSC report

2.2.5(b) Pre-Survey Report

The pre-survey report is a useful tool to have in the field, especially when not using the MS^3. This report contains much of the system inventory data found on the DWS, as well as the previous six years of sampling data, and the checklist questions. Staff should create a pre-survey report for each system prior to performing a sanitary survey. This is accomplished by hitting the “Create Pre-Survey Report” button on the sanitary survey screen. Creating a pre-survey report before a survey is not always necessary if staff use the MS^3 since the system inventory and checklist questions are part of that. However, TN inspectors will still need to include a completed pre-survey report with their assessment letter since the more simplistic TN assessment letter does not include all of the system inventory data that EPA wants to see in a complete Assessment Report.

2.2.6 On-Site Inspection – TN Groundwater Systems (1/12/11, updated 09/10/2019)

TN surveys are usually the simplest to perform and should generally take about four hours to complete including paperwork and follow-up. However, this is highly variable especially if there is a lot of travel involved. Surveys should be scheduled well enough in advance to give the owner/operator ample opportunity to make sure they are able to be present during the time of the survey. It is important that a primary contact for the system be present during the survey to answer questions and discuss findings.

There are eight elements that must be evaluated during any sanitary survey (NR 809.35(5)). They are as follows:

2.2.6(a) Source

An evaluation of the source is essentially an evaluation of the potential for contamination to enter the water supply. This includes a thorough inspection of the well terminus and a survey of the surrounding area for potential contaminant sources.

Well Terminus See NR 812, for specific requirements.

Inspectors should make sure that the well seal/cap is code complying. It must be adequately sealed to prevent entrance of foreign material. There should not be any missing bolts. Electrical wires should be enclosed in sealed conduit that terminates at least two feet below grade. If present, the vent should be screened, downward facing and terminate at least one foot above ground surface or the pump-house floor. Screens shall be made of material not easily corroded and shall be firmly seated in the vent opening. Vent openings incorporated as part of the underside of an approved well cap or seal are allowed. Screens must be in good condition. NR 812.30(3).

- Vermin proof caps, full plate sanitary seals, threaded sanitary seals, turbine and hand pump bases are allowed.
- Overlapping caps were allowed before 1991. After 1991 they were not allowed. If a PWS has a pre 1991 overlapping cap, inspectors should recommend that it be replaced with a vermin proof cap. If an overlapping cap fails it **must** be replaced with a vermin proof or other code complying cap.
- Split plate sanitary seals are not allowed unless enclosed in a substantial, permanent weather proof shelter. NR 812.30(3).

Inspectors should attempt to locate the well construction report for all the active wells at a PWS. These should be in the facility file, available in DWS or may be found using online tools. If a well construction report is not available buried portions of the well construction are not evaluated during the sanitary survey. However, an investigation of the casing depth and grout may be required if unsafe water is reported in the future. Every public well should have a WUWN. If a well construction report exists the well casing depth should be compared to the requirements in NR 812 tables I & II for low capacity wells, and tables III & IV for high capacity and school wells. Generally, low capacity wells must have a minimum of 25 feet of casing, and high capacity and school wells must have a minimum of 60 feet of casing, but site specific geology is also a consideration.

The casing must not be stovepipe, cracked, or severely corroded. Neat cement grout shall be used to seal the annular space:

1. Of low capacity wells when the upper enlarged drillhole is constructed more than 5 feet into a bedrock formation,
2. Of low capacity bedrock wells when bedrock is encountered within 40 feet of the ground surface or within 30 feet of the ground surface if the bedrock is sandstone,
3. Of potable high capacity wells,
4. Of school wells,
5. Of wastewater treatment plant wells,

6. When a liner pipe is installed for the purpose of preventing water containing contaminants with levels exceeding the drinking water standards of s. NR 812.06 from entering the well.

NR 812.20(1)

The well must be grouted using neat cement (or another approved grouting material). Documentation must be provided to indicate the well is grouted. Systems may be allowed to demonstrate that the grout exists.

The inspector should also review the well construction to ensure that the well is not a "dual" aquifer well. This situation occurs in the eastern part of the state where the sandstone and dolomite aquifers are separated by a relatively impermeable layer of shale. A well may be completed either into the dolomite or the sandstone, but should not be open to both aquifers. The head differential between the aquifers can allow rapid contaminant movement negating the protection provided by the impermeable layer. Dual aquifer wells must be filled and sealed or lined to isolate the two aquifer systems.

Inspectors should verify the casing height with a tape measure. In most instances, the casing height should be equal to or greater than 12 inches above the established ground surface, or the floor of an enclosure.

- Wells constructed before 1953 only had to be greater than 6 inches high.
- Between 1953 and 1991 they were required to be at least 8 inches.
- After 1991 they had to be at least 12 inches.
- Wells located in a floodfringe or floodway must terminate at least two feet above the regional flood elevation. The regional flood elevation is the elevation that a 100 year flood could be expected to rise to. "Floodway" means the channel of a river or stream and those portions of the floodplain adjoining the channel required to carry the regional flood discharge. "Floodfringe" means that portion of the floodplain outside of the floodway which is covered by flood water during the regional flood. The term floodfringe is generally associated with standing water rather than flowing water. Wells can be reconstructed or replaced in a floodway/floodfringe but new well construction can't occur if no wells existed previously. Additionally, dry land access to the pumphouse must be provided so that the facilities may be reached using a vehicle during times of flood.

The minimum casing height for an existing well installed within a pit or alcove is six inches if installed on or before April 10, 1953 and 12 inches if installed after April 10, 1953. A pit or alcove well installed on or before April 10, 1953 that has less than a six inch casing height must be extended out of the pit or alcove to 12 inches above the outside grade or the pit or alcove roof if the extension causes an obstruction.

<u>Location See NR 812, for specific requirements.</u>

Wells should be in a code complying location that is easily accessible for maintenance. They should not be located in an area that is subject to traffic damage, or in non-complying pits or alcoves, basements, or under building floors.

The top of a well casing pipe may terminate in a walkout basement if the following conditions are met:

1. It is possible to walk directly outside from the walkout basement without walking

upstairs or upslope.

2. The surface of the ground around the outside exit door of the walkout basement slopes down away from the door.
3. The well and pump installation are accessible for repair and removal.
4. The well produces water continuously free from contaminants in excess of the drinking water standards of s. NR 812.06.
5. The well casing pipe depth meets the requirements of s. NR812.42(1)(b).
6. The well and pump installation are in compliance with all other requirements of this chapter.
7. The walkout basement is not subject to flooding
8. The walkout basement is not in a floodway or floodplain.
   NR 812.08(2)(d)

A well pit constructed after April 10, 1953 requires approval from the department to verify that the pit construction standards of NR 812.36 are met. The minimal construction requirements for approved new well pits are illustrated in Figure 45. The construction specifications are provided in s. NR 812.42(2) for well pits constructed on or before April 10, 1953 and in s. NR 812.36(2) for all other well pits.

Extending the casing out of a noncompliant pit constructed on or before April 10, 1953 is common practice that requires no department approval and typically costs less than modifying the construction of the pit.

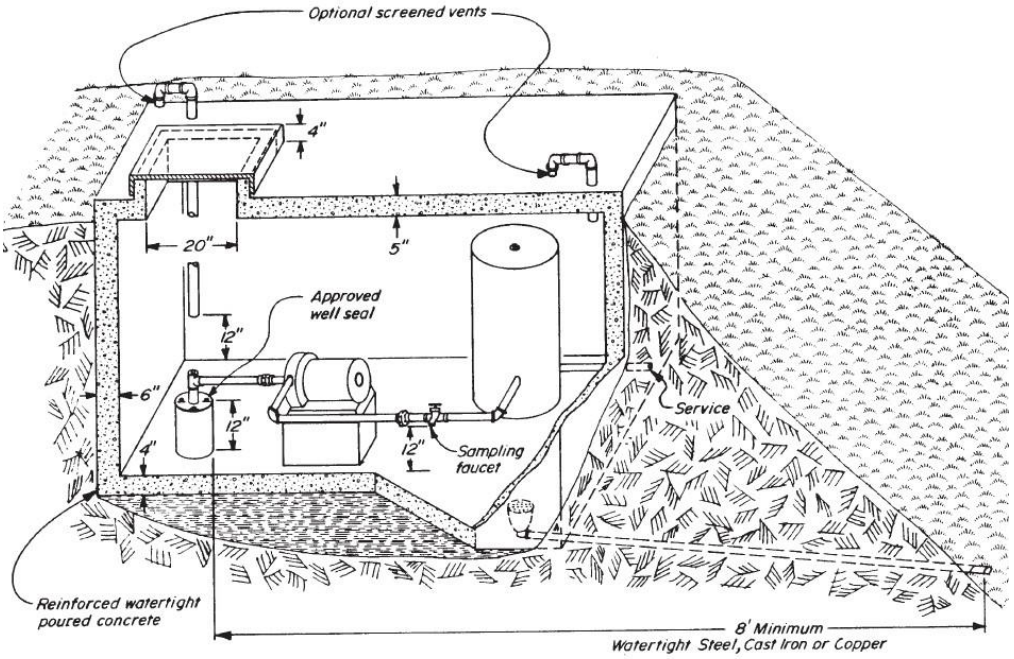


Figure 45. Minimum requirements for approved new well pits.

Setback Distances

The area surrounding the well should be checked to determine if there are any new potential hazards to the water supply, i.e., flooding, fuel storage or other contamination sources. Some of the more common potential contamination sources are listed on the

pre-survey report form. For a more complete list see NR 812.08. Previous sanitary surveys and monitoring assessment documents are a good place to look for already documented potential sources of contamination. When in doubt, inspectors are advised to consult with Remediation & Redevelopment Program staff. Inspectors should check to see if any waivers have been granted for sources of contamination that do not meet the required setback distances.

A site sketch should be included in the assessment report that displays the location of the well in relation to potential sources of contamination and buildings associated with the system. This can be a hand drawn sketch, however aerial pictures are easily obtainable for most systems by selecting "Map of Well" on the monitoring assessment page of the DWS, or via internet mapping sites. Aerial photos can be pasted into the Pre-Survey Report and labeled electronically or by hand.

Well Filling and Sealing NR 812.26, NR 810.22.
Inspectors must verify that there are no wells on site that require filling and sealing. Wells that have not been in use for more than 90 days, or have one or more water quality parameters over the primary drinking water standard, must be permanently filled and sealed unless department approval is obtained to continue the well in service. Wells must be filled and sealed by someone that is licensed to do so. Inspectors should verify that unused wells have been filled and sealed correctly including appropriate approvals. A copy of the well abandonment report should be in the facility file. Emergency wells can have an extended abandonment agreement provided they meet the requirements of NR 810.22.

2.2.6(b) Pumps/Facilities & Controls See NR 810 and 812, for specific requirements.

Inspectors must verify that pumps, facilities, and appurtenances meet NR 812 requirements. In most instances submersible pumps can not be inspected, but the condition of offset pumps (jet pumps) can be visually checked. Shallow well jet pumps, or suction pumps, use centrifugal force to draw water out of a well. Deep well jet pumps use both suction at the jet to bring water into the piping and pressure applied by the impeller to lift water in the piping out of the well. Offset pumps should also be the correct height to protect from flooding.

- ≥ 12 inches (above a basement or pit floor) if installed after 1991, NR 812.32(2)
- ≥ 6 inches (above a basement or pit floor) if installed before 1991, NR 812.32(2)
- Recommend 12 inches above ground elevation

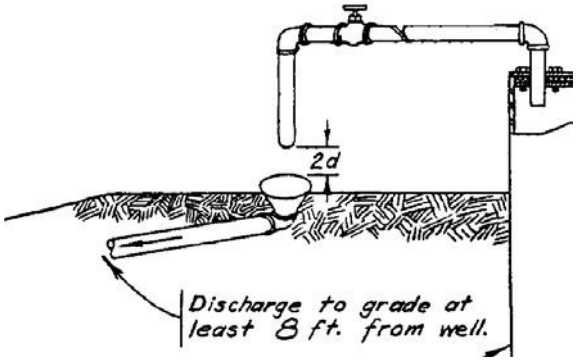
Buried suction lines must be under positive pressure or be protected with a pressurized concentric outer pipe (pressure conduit). Buried discharge pipes from submersible pump installations are under positive pressure. Buried discharge pipes in jet pump installations are under negative pressure and if there is not a pressurized conduit surrounding it contaminants can enter the system. For a similar reason check valves should not be located upstream from a pressure tank. A check valve between the pressure tank and a submersible pump can cause an increased risk of contamination in situations where pressure falls in buried lines before the pump kicks back on to pressurize the buried part of the system.

In all pressure water systems, whether installed before or after 1991, provision shall be made for collection of water samples directly from the well by installation of a sampling faucet at or upstream of the pressure tank and upstream of any water treatment equipment.

The sample faucet shall be installed at least 12 inches above the floor, have a downturned spout and be in an accessible location. All sample faucets shall be metal and shall have an inside diameter of at least one−quarter inch. The sample faucet shall have a smooth end. Threaded faucets and threaded drain valves may not be installed in place of a smooth end sample faucet even if the threads have been filed off. Petcocks may not be used as sample faucets. NR812.34, NR812.42(11)(b)

If present, pressure gauges should be in good working condition. They should not be cracked or full of water. There is no code requirement for a minimum system pressure at non-community systems, however it is advisable to maintain pressure at least above 20 pounds per square inch (psi).

When a flowing well is placed in use, the flow from the well shall be regulated by means of a control valve with a screened outlet or with a restricting orifice to prevent waste of water. A controlled overflow pipe or other means shall be installed for a flowing well to prevent damage from overflowing water or to prevent freezing of the top of the well. The control valve shall be restricted as much as possible and closed if the flow ceases. The overflow pipe must be at least 12 inches above grade and at least two pipe diameters above any discharge receiving line. The receiving drain should discharge at least eight feet from the well.



Hi-Cap Wells must have a means to measure water levels. The owner or operator of a high capacity well or well system also must submit pumpage and well water level reports to the department on department forms at the time periods indicated by the department. Verify that this is taking place.

2.2.6(c) Treatment

All treatment devices, regardless of their purpose, must be noted in the DWS. Treatment devices for primary contaminants must be inspected to make sure they meet approval conditions, including adequate chemical measurement capability, use of approved NSF 60 chemicals, and feeders with back siphon protection. Treatment devices for aesthetic issues should also be properly maintained (particulate filters changed, softener brine replaced, etc.).

New treatment devices for primary contaminants installed at non-community systems need site specific approval prior to installation (NR 812.37(3)). This is currently handled by the Department of Safety and Professional Services (DSPS), however DNR had this responsibility in the past. The DNR also needs to approve installation of treatment in lieu of construction of a new well required by NR 812.37(2)(e). This is typically done through the use

of a compliance agreement or consent order that allows the system to investigate their options whether it be a new well or treatment in resolving their problem. This enforcement document establishes a time frame to the system to evaluate options and identify the preferred option, propose the preferred option to DNR, allow time for DNR to consider the preferred option, for the system to obtain DSPS approval if appropriate, complete installation and return to compliance.

2.2.6(d) Storage

All storage facilities must meet NR 812 requirements. At TN systems, pressure tanks are the most common storage. The department recommends that pressure tanks be sufficiently sized to provide the minimum pump run time recommended by the pump manufacturer. They must be inspected to make sure they are not corroded, leaking, damaged, water logged, or located in an area subject to flooding. Water logged pressure tanks can sometimes be detected when the pump kicks on and off frequently, but pressure does not increase very much. An approval shall be obtained for pressure tanks having a gross volume greater than 1,000 gallons. The department recommends that pressure tanks having a volume greater than 1,000 gallons be installed above ground. Buried pressure tanks shall be constructed of steel, fiberglass or other comparable non−metallic composite material. When pressure tanks are buried any air unloader pipes or tank air valves shall extend at least one foot above grade.

Nonpressure storage vessels, designed as part of a potable water supply system, may not be used without approval. Approval is required regardless of whether or not there is a free−air gap in the water inlet line upstream of the vessel. The installation of a surge tank is exempt from this approval requirement. Surge tanks shall meet the requirements for pressure tanks described in s. NR 812.33(1).

Reservoirs must also be evaluated where applicable and meet the requirements of NR 812.33(2). Common problems include the corrosion of vent or overflow screens, deterioration of paint and steel structures, and cracks in ground storage reservoirs, which frequently are the cause of contamination. An interior inspection of ground storage reservoirs should be scheduled if none has been performed in the last five years.

2.2.6(e) Distribution System

Check for potential cross connections. An exhaustive search of the system for cross connections is not necessary unless there is an on-going bacteriological contamination issue, however, if obvious examples are present they should be noted and corrected. At a minimum threaded hose bibs should have vacuum breakers installed, and discharge lines (e.g., softener backwash, ice machines, etc.) should be at least two pipe diameters above the rims of sinks and floor drains.

2.2.6(f) Operations & Management

Past inspection deficiencies should be reviewed before the survey and checked on site to make sure they have been corrected. Verification of corrective actions for significant deficiencies requires a signature from either the PWS or the inspector. For this reason it should be an infrequent occurrence for significant deficiencies to have not been corrected by the time of the next survey. In the event that the PWS signed the corrective actions

verification form stating that significant deficiencies were corrected and it is discovered that they were not, the PWS will immediately be issued a TTV with the requirements for a Tier II Public Notice (PN), an enforcement conference and a compliance agreement or consent order. Subch VII, NR 809.

Minor deficiencies do not require a signature on the corrective actions verification form, so it is more likely that these types of deficiencies will not have been corrected. If inspectors find un-corrected minor deficiencies at the time of the next survey, the PWS should be given a significant deficiency for the operations & management element of the survey. This will then initiate a more rigorous process of verification and potential enforcement.

An intrusive examination of the system's finances is not advisable, however, it is important that owners understand the costs of operating a public water system. Inspectors should note the age of certain major system components like the well, pump, and pressure tanks. If these are getting old, it would be helpful to the owner to mention that they may need replacing in the near future to get them planning for this expense.

Inspectors should verify that public notification procedures have been adhered to. Boil water notices for bacteria, and postings for nitrate/nitrite above the MCL should be located in conspicuous locations. Failure to do so should generally be regarded as a significant deficiency.

2.2.6(g) Monitoring & Reporting

Verify that there are updated monitoring site plans on file with the department for bacteria and nitrate. These may need updating during the sanitary survey, or if they are not available they may need to be created during the survey. Bacteria monitoring sites should be representative of the entire system, and sample collection should rotate through the list of approved locations over time. The system must be in compliance with their monitoring requirements with respect to samples taken and frequency. NR 809.

Ask about the procedures used for sample collection if the person collecting the samples is present. In some instances it may be helpful to ask the sampler to collect their samples during the survey. Make sure the sampling procedure is appropriate for each type of sample collected (raw water, entry point, distribution). Commend good sample collection procedures and offer advice on how to improve poor procedures.

Review the monitoring results for each well. If water quality has changed over time, note the trends and alert the PWS about this situation. For example if nitrate results have steadily increased over the years and are approaching 10 milligrams per liter (mg/L) it would be good to make the owner aware of that fact.

Wells that have recurring problems with fecal coliform must be replaced unless the problem can be identified and corrected. Treatment may be installed in-lieu of well replacement in cases where it is demonstrated that alternative wells of sufficient capacity cannot be constructed. The treatment installed must be capable of 4 log inactivation/removal of viruses. Similarly, wells with nitrate levels over 10 mg/L will need corrective action. Continued operation is allowed between 10 and 20 mg/L for a limited time. Wells with nitrate over 20 mg/L will have to either be replaced or provided with treatment when it is demonstrated that alternative wells of sufficient capacity cannot be constructed.

2.2.6(h) Operator Compliance

Certified operators are not required for TN systems, however it is important that there is somebody that takes responsibility for managing the PWS. There should be somebody that is the primary person responsible for collecting samples, maintaining treatment chemicals/filters, following through with corrective actions, posting PNs, etc. This is usually an owner however in rare instances there may not be a clear understanding of who is taking responsibility for maintaining the PWS.

2.2.6(i) Review Findings

When the inspection of the system is complete, staff should review the findings with the owner. This is an opportunity to explain what will be in the assessment letter and what will be required of the owner to correct any deficiencies. This is also a good opportunity to come to some initial agreement on compliance due dates.

2.2.7 On-Site Inspection – NN Systems (09/10/2019)

This subchapter of the operations handbook is a guide for DNR staff conducting sanitary surveys at **non-transient non-community (NN)** water systems. Sanitary surveys for NNs are conducted at least once every five years according to NR 810.42(1)(e)2. Water supply specialists are expected to conduct 20 percent of their surveys yearly to meet their performance measures. This results in an evenly distributed workload from year to year. Each sanitary survey needs to be completed within five years of the date the previous survey was done. The sanitary survey report or a sanitary survey report including notice of noncompliance language is expected to be sent to the system within 30 days of the date the current sanitary survey was completed.

Non-transient non-community water systems, as defined in NR 809.04(57), serve at least 25 of the same people for at least 6 months of the year. These systems include schools, day care centers, factories or businesses with 25 or more people with the ability to be regularly served by the water system. Other potential NN systems may include farms, equipment dealers, food production facilities, restaurants, retail stores, strip malls, vehicle dealerships, warehousing facilities and power plants that have 25 or more employees. They may also include assisted living buildings, nursing homes and health care facilities that regularly serve a combined total of 25 or more individuals with residents and staff but have less than 25 residents living on site. The total number of individuals regularly served by a NN system includes all employees that may regularly be on site during the day rather than the maximum number of employees on site at any one time during the day. Consider this factor when determining whether facilities that operate multiple shifts would be appropriately classified as NN systems.

Water consumers at NN systems can potentially be exposed to drinking water contaminants (subjecting users to both acute and chronic health risks). Note that providing bottled water is not an acceptable way to achieve compliance with the corresponding maximum contaminant levels if a water system meets the public water system criteria. This is provided by NR 809.10.

A NN system can vary from simple to complex. DNR staff should schedule sanitary surveys well enough in advance to make sure the owner and/or operator are able to be present during the survey. It may be helpful to indicate the anticipated amount of time it will take for

completion of the survey. It is important that a primary contact, preferably the person most knowledgeable about the water system, accompany the surveyor during the survey to answer questions and discuss findings.

Non-transient non-community water systems are regulated through NR 809, 810 and 812. Operator certification requirements are specified in NR 114.
There are eight elements to evaluate during a sanitary survey. They are as follows: Source; Pumps, Facilities and Controls; Storage; Treatment; Distribution; Operation and Management (O and M); Monitoring and Reporting (M and R) and Operator Compliance. These elements and post-survey follow up are covered in the following sections. Pre-survey preparation resources are provided in *Public Water Supply Operations Handbook* Appendix 2.20.

The EPA documents below provide additional guidance for staff conducting sanitary surveys of NN systems:

- Sanitary Survey Guidance Manual for Ground Water Systems [Exit DNR],
- Drinking Water Inspector's Field Reference [Exit DNR], and
- How to Conduct A Sanitary Survey of Small Water Systems A Learner's Guide [Exit DNR].

Related information can also be viewed in DNR's Small Water System Operator Certification Manual.

2.2.7(a) Source

Definition: A review of the system's raw water source is conducted to prevent potential contamination or water quality degradation. This includes a thorough inspection of the wellhead and a survey of the surrounding area for potential contaminant sources.

Objectives: To review the major components of water sources that determine water quantity, quality, reliability and vulnerability. Note that All NN water systems in Wisconsin rely on groundwater as their source.

Applicable Wisconsin Administrative Codes regarding source requirements for NN water systems in Wisconsin:

- NR 809 – minimum standards and procedures for using source water and requirements for the protection of the public health, safety and welfare in the obtaining of safe drinking water.
- NR 810 – temporary water and alternative source waters (NR 810.17 and 810.42), emergency wells (NR 810.22), water system security (NR 810.23) and system capacity (NR 810.24).
- NR 812 – well construction requirements and finished well components (NR 812.01-26; 812.29-31; 812.40 and 812.42).

- NR 820.13 – high capacity well pumpage reporting requirements.

1. Quantity of Water

A. Water system capability and estimating source capacity

The specialist performing the sanitary survey should evaluate the ability of the system to meet the demands placed on all of its components. This is required by NR 810.24 prior to serving water and during each sanitary survey. If it is determined that the system has a history of inadequate supply issues based on repeated low pressure or no running water events, the surveyor may consider the design production capacity and the average daily production, if metered use is provided. Inadequate well yield, flow or pressure in the system can also be taken into account. This can result when demand exceeds the capacity of the source of supply, transmission lines, pumps, storage facilities or distribution system piping.

An evaluation of average daily production trends may indicate problems. For example, if consumption is higher than in similarly sized systems, or if production trends are increasing without an accompanying population or use increase, excessive leakage may be occurring within the water system.

Typical daily estimated water use values for some common NN system service types are provided in the following table:

Non-transient, non-community system	Estimated water use (gallons per day)
Factories, no showers (per person)	25
Factories with showers (per person)	35
Office Buildings (per person)	20
Retail Stores (per employee)	20
Hospitals (per bed)	300
Elementary School/Day Care (per person)	15
High School & Jr. High (per person)	20

From: *Guidelines for Design of Small Public Groundwater Systems*. Ohio Environmental Protection Agency, 2015.

B. Making improvements to satisfy system demands

Capital improvements may be necessary if average daily production approaches or exceeds the design capacity of major system components. Operating records should provide this information. When operating records are not available, the specialist should be prepared to make reasonable estimates.

Capital improvements which result in the addition of new system components (wells, discharge piping or storage) or those that have the potential to change the quality or quantity of water provided may require DNR approval (NR 812.09). Improvements such

as system maintenance that have like-for-like component replacements likely do not require DNR approval. Check with the responsible plan review representative or the Public Water Engineering Section Chief for more information.

Ensure wells are able to produce enough water to meet daily demand, especially for larger NNs such as factories and power plants. Indicators of poor capacity can be frequent pump operation (timing during inspection), hourly or daily data from run time meters, low pressure or no water complaints, or frequent pump replacement. The NN system owner/representative may want to consider adding one or more back-up sources if it is critical for the public water system to have a source of potable water at all times.

C. Permitting and high-capacity wells

An owner of a high capacity well shall apply to the department for approval before construction begins as stated in Wis. Stat. § 281.34(2). Note that Wis. Stat. § 281.34(2g) provides approval exemptions for the repair, replacement, reconstruction and transfer of ownership of an approved high capacity well. In accordance with NR 812.09(4)(b), prior DNR approval is necessary prior to the construction, reconstruction or operation of a school or wastewater treatment plant well or water system.

A high capacity well is a well that has the capacity to withdraw more than 100,000 gallons per day (70 gallons per minute or greater pump capacity), or a well that, together with all other wells on the same property, has a capacity of more than 100,000 gallons per day per NR 820.13. Note that this capacity excludes residential or fire protection wells as provided by 2015 Wisconsin Act 177.

D. Plan review and approvals

Plan review is required for school, wastewater treatment facility or new high capacity wells or well systems; for the operational or infrastructure changes resulting in a change to the quantity of water delivered from an existing public high capacity, wastewater treatment facility or school well system; or modifications to the pump or its associated pressure system upstream of the first pressure or storage vessel that may lead to changes in water quality from an existing public high capacity, wastewater treatment facility or school well systems. Under Wis. Stat. § 281.34(2g), a new high capacity well approval is not required for repair and maintenance, replacement, reconstruction or the transfer of an approved high capacity well. Note that conditions describing when approval would be required for a replacement high capacity well are provided in Wis. Stat. § 281.34(2g)(a)2.b. In addition, DNR plan review is not required for like-kind replacement of equipment such as pumps that are equivalent capacity, construction and/or function (i.e. a 35 gallon per minute submersible well pump for a 35 gallon per minute submersible well pump replacement).

If proposed system improvements require plan review, inform the NN system representative of the need to apply to the DNR for any such approvals outlined in NR 812.09. Code prior to construction to prevent future deficiencies, notices of noncompliance or enforcement action, Additionally, NR 812.09(3) requires that plans and specifications for a school water system shall be submitted by a registered professional engineer or well driller for wells, and by a registered professional engineer or pump installer for pumps, discharge piping, storage tanks and controls.

Well and water system construction plan review and approvals, when required, are generally handled by central office plan review staff. Field staff are encouraged to share sanitary survey reports, enforcement documentation and other site-specific information that may be useful for plan review staff who are evaluating the application materials that have been submitted.

E. Interconnections

Locate and describe any water system interconnections and determine if a contingency plan exists for water source outages. It is important that the system has a plan to deal with water outages, so it can quickly correct their causes. Emergency water supplies should be made available during extended outages.

Interconnections between a NN system and another source of water is prohibited unless approved by the DNR in individual cases. Approval of the DNR shall be obtained prior to the interconnection (NR 810.15(2)).
Hospitals may be classified as NN systems and may be required by other agencies to have a defined secondary source of drinking water for emergency operations. This dedicated secondary source may be by interconnection to another water system or from additional wells. Unused secondary sources could be a source of contamination if not operated on a regular basis.

F. Abandoned or auxiliary sources

Unused sources should be physically disconnected. Abandoned or unused wells should be filled and sealed properly to prevent contamination of the aquifer (NR 812.26). Discuss proper filling and sealing procedures with systems that may have idle, underutilized or very aged wells. Extended well abandonment agreements are required for emergency or back-up wells that are not used for any other purpose. Additional information on this topic is provided in NR 810.22.

2. Quality of Water

A. Formations and aquifers

Currently, all NN water systems in Wisconsin rely on groundwater as their source. Geological formations and aquifers that are present in a given well location determine a well's construction criteria and water quality. 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. Refer to additional resources for more information on geological formations and aquifers used for drinking water in Wisconsin. Groundwater section staff may be one source for such resources.

B. Location and siting of wells

Groundwater generally has a more consistent and better microbiological quality than surface water, having undergone considerable natural purification through straining and

prolonged storage. However, groundwater systems have suffered source water contamination due to chemical application/storage/disposal or bacteriological contamination. Therefore, well locations should be carefully selected and managed to reduce contamination vulnerabilities. The likelihood of contamination is increased by the proximity of the water source to, for example, sewers, septic tank waste disposal, construction projects, animal pastures, land application of organic and inorganic compounds, chemically treated agricultural land and chemical storage areas. Other sources of contamination are natural
such as: arsenic, manganese or barium in soil and rock formations; and decomposing organic matter.

- **Well placement:** A well shall be located so the well and its surroundings can be kept in a sanitary condition according to NR 812.08(1)(a). As much as reasonably possible, it should also be located at the highest point on the property as required by NR 812.08(1)(b), so it is protected from surface water flow and flooding. The well shall also be as far from any known or possible contamination sources as the general layout of the premises and the surroundings allow as required by NR 812.08(1)(c). Wells should not be located in an area that is subject to traffic damage, or in non-complying pits or alcoves, basements or under building floors.

- **Setback distances:** The area surrounding the well should be checked to determine if there are any new potential hazards to the water supply, i.e., flooding, fuel storage or other contamination sources. Some of the more common potential contamination sources are listed on the pre-survey report form. Approved locations and minimum separation distances for NN system wells from some common contamination sources are specified in NR 812.08 and corresponding Table A. Previous sanitary surveys and monitoring waiver assessment documents are a good place to look for already documented potential sources of contamination. Specialists should check to see if any waivers have been granted for sources of contamination that do not meet the required setback distances. During the survey, a long tape measure should be available to measure any new or unreported contamination sources that need a setback distance compliance verification.

- **Monitoring waiver assessments:** Formerly referred to as vulnerability assessments, these assessments are updated at least once every three years in order to identify possible sources of contamination in the area of wells. Monitoring waivers reduce or eliminate monitoring requirements for certain contaminant groups (i.e., volatile organic contaminant monitoring frequency reduced from once every three years to once every six years) or individual contaminants (i.e., elimination of required benzo-a-pyrene monitoring). Monitoring waivers are permissive and may be granted under federal rule (40 CFR 141) and by the corresponding section of NR 809 in which the monitoring frequency for each non-microbiological regulated contaminant is described. Monitoring waivers are available for most inorganic compounds, volatile organic compounds and synthetic organic compounds. A monitoring assessment includes an evaluation of well *vulnerability* based on criteria that includes: identification of potential contaminant sources within a defined review area;

previously detected contaminants; analysis of local geology; and an evaluation of well construction criteria. After a monitoring waiver assessment has been completed and entered in DWS, a specialist can look at past contaminant detects, review well susceptibility categorization and analyze generated vulnerability maps.

C. Source water protection

- **Vulnerable formations:** Consider reviewing well documentation to see if the water-bearing formation is classified as confined (e.g., clay layers or other aquitards are located between the water-bearing formation and the ground surface) or unconfined (e.g., sand and gravel). Because the top of the sand and gravel aquifer is also the land surface for most of Wisconsin, it is highly susceptible to human-induced and naturally occurring pollutants. Confined aquifers are generally less susceptible to contamination. Unfractured bedrock can serve as a confined aquifer. However, in parts of Wisconsin, particularly areas in Door, Kewaunee, and Manitowoc counties, there is little to no soil covering fractured dolomite, which can be susceptible to groundwater contamination. Wells constructed or reconstructed to withdraw water from any of the aquifers beneath the "Maquoketa" shale and the "Niagara" formations in the eastern part of the state shall be cased and grouted at least through the "Niagara" formation except in areas designated by the DNR as special well casing pipe depth areas as provided in NR 812.14. Refer to geological resources for formation descriptions. The Drinking Water & Groundwater Monitoring Waiver Vulnerability Assessment Viewer can be used for spatial assessment of vulnerable areas at: Vulnerability Assessment Viewer.

- **Flooding:** Determine if the well site is subject to flooding. When questions about floodplain, floodway or floodfringe boundaries come up, first consult with the DNR water management engineer for the county in which the proposed or existing well is located. County zoning department staff may also be able to assist with questions. Floodplain information is available on DNR's Surface Water Data Viewer. However, the disclaimer for this website indicates it is for informational purposes only and not to be used for regulatory purposes such as floodplain zoning.

- **Pollution:** *Are there any pollution sources near the well? Is there an emergency spill response plan, in particular for NNs that are in industrial or agricultural settings?* Larger facilities with bulk chemical storage may have a spill prevention, control and countermeasure (SPCC) plan.

- **Special casing area:** *Is the system looking to reconstruct an existing well or construct a replacement well on site to address a primary/secondary regulated contaminant, increase capacity, address an aesthetic issue, etc.?* If so, the specialist should make sure the system representative is aware of any special well casing areas. This information can be viewed using the well driller viewer available on the external DNR Internet website at: Well Driller Viewer.

- **Flowing wells:** Specialists may occasionally encounter flowing wells in areas of high or perched water tables. NR 812.32 discusses important features for flowing wells such as an overflow pipe that has a control valve with a screened outlet or a restricting orifice to prevent waste of water. Additional well construction criteria specifically for flowing wells are provided in NR 812.15.

- **Wellhead protection:** *Does the system have a wellhead protection plan, or does it fall under a local ordinance that requires one?* On a system-specific basis, this involves delineating the wellhead protection area, inventorying the potential sources of contamination, managing the wellhead protection area and planning for contingencies. Measures that can be used to protect the source include ownership of the recharge area and zoning ordinances or regulations that prohibit certain land uses within the recharge area. The specialist should determine if recharge area protection, such as a wellhead protection plan, is in place and should evaluate its effectiveness. While a beneficial tool for protecting groundwater quality, few NN systems have wellhead protection plans due to the challenges associated with managing a wellhead protection area that may include property the system does not own or operate.

D. Water sample quality

Discuss the system's water quality history. This includes the detected presence of contaminants, primary and secondary, and if these samples indicated problems with the source water. *Has there been a change in water quality such as frequent presence of total coliform or E. coli, increasing nitrates or increasing levels of arsenic?* Although rare, sometimes a change in source water is necessary in order to continue to provide safe drinking water for consumers.

- **Microbiological quality:** Bacteriological compliance monitoring and maximum contaminant level (MCL) violation follow-up for groundwater systems are addressed in NR 809.30 through 809.329, and in Chapter 6 – Water Quality Monitoring. Direct questions about microbiological monitoring to the public water system monitoring coordinator.

- **Primary chemical contaminant standards:** Every groundwater source must be examined for nitrate and nitrite by analysis of representative samples in a laboratory certified by the DNR before it can be used to serve a public water system. This is required by NR 809.115(4)(a) and 809.115(5)(a), respectively. Routine compliance monitoring and MCL violation response for nitrate, nitrite, arsenic, other inorganic contaminants (IOCs), volatile organic contaminants (VOCs) and synthetic organic contaminant (SOCs) considered primary regulated contaminants are mentioned in the corresponding sections of NR 809, and in Chapter 6 – Water Quality Monitoring. Direct questions about primary regulated chemical contaminant monitoring to the public water system monitoring coordinator.

- **Secondary inorganic chemical and physical standards:** The presence of secondary and other aesthetic contaminants may need to be analyzed and any contaminant concentrations above the secondary limits may require corrective

action. More information on secondary standards is provided in NR 809.70, and in Chapter 6 – Water Quality Monitoring. Direct questions about secondary regulated contaminant monitoring to the public water system monitoring coordinator. Note that water systems with excessive levels of iron and manganese, can result in color, odor and taste complaints. Abnormally high amounts of chlorides, sulfates or total dissolved solids can also make water objectionable for drinking. High levels of sodium are a concern when serving water system users with sodium restricted diets.

Well drilling and pump work water samples required in applicable sections of NR 812 are not considered to be routine public water system compliance samples required by NR 809. The following fact sheet provides information on well drilling and pump work sampling: *Water Sample Requirements: A fact sheet for drillers and pump installers*. Note that well drilling and pump work samples are not required to be electronically reported to public water system program staff and most often will not appear in the Drinking Water System (DWS) database. Contact private water field staff or in central office for additional information or clarification.

3. Well Construction and Installations

A. Well construction reports

Inspection of a well during a sanitary survey will include a review of the well construction report for construction methods, well depth, well casing depth, water-bearing formation(s) and annular space sealing material (e.g. cement grout or drill mud and cuttings) as well as visually observing the well cap/seal, vent (if present), well casing height, well location and surrounding area. Specialists should attempt to locate the well construction report for all active wells serving a NN system. This can be done using the 1930-1989 well construction report inventory managed by the Wiscosnsin Geological and Natural History Survey (https://data.wgnhs.wisc.edu/well-viewer/ [Exit DNR]) and/or the 1989-present well construction report inventory in DWS). If a well construction report is not available, buried portions of the well are not evaluated for compliance with applicable construction criteria during the survey. The well cap or seal should not be removed from the well casing by DNR staff for the purpose of obtaining information about how the well may have been constructed. However, an investigation of the well depth, casing depth and annular space sealing material by a licensed well driller or pump installer may be required if contaminated water is reported during the sanitary survey or in the future.
Wells serving public water systems have been issued a Wisconsin unique well number (WUWN) since 1988. Every public water system well should have a WUWN. Specialists should issue a WUWN for any public water system wells they encounter that have not been assigned a WUWN. If needed, WUWN identification stickers may be obtained from private water specialists.

B. Well construction methods

- **Drilled wells:** Almost all modern wells constructed for public use are drilled wells. 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 (rotary) method.

- **Driven wells:** These wells are constructed by driving a pipe with a point and screen into the ground. Because they are often installed in areas with sandy soils, they are also called “sand point” or “driven point” wells. Due to the limitations in how deep sand point wells 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. These types of wells are allowed for NN systems, but require DNR approval for school well installations.

- **Dug wells:** Dug wells have typically been constructed in areas with very high groundwater levels. They utilize a constructed box or circular structure which allows water to seep into the well, where it can then be withdrawn from the well for use. These wells were widely used before modern drilling equipment was invented. These wells often pose a safety hazard and are prone to contamination (NR 812.24). The DNR strongly discourages their construction or use; hence they are no longer very common in Wisconsin.

C. Well casing

- **Steel well casing pipe** is installed in wells to keep the upper enlarged drillhole from caving in during well construction, especially in unconsolidated formations. It also prevents contamination from entering the well and groundwater after a well is constructed. In Wisconsin, casing pipe depth requirements are based on whether the well is constructed in an unconsolidated (e.g., sand and gravel) formation or bedrock. Because the top layers of some rock formations can be somewhat porous, casing in bedrock is installed into the rock formation to a depth where solid (also referred to as competent) bedrock is encountered.

- **Thermoplastic (also known as PVC) well casing pipe:** As specified in NR 812.13-16, PVC well casing pipe may be used instead of steel casing pipe for low capacity wells, not including school or wastewater treatment plant wells, and for nonpotable high capacity wells. Specifications for PVC well casing are provided in NR 812.17. Only steel well casing pipe may be used for potable high capacity, school and wastewater treatment plant wells. Thermoplastic well casing pipe may not be used for bedrock wells. In addition, PVC casing is not recommended at locations where there is a chance that the overlying soil contains hydrocarbons that could permeate the casing and contaminate the deeper water being used.

- **Casing diameter:**
  - The minimum diameter for all newly drilled wells in unconsolidated formations is provided in NR 812.13. Note that the provided minimum casing diameters are based on the nominal size of the well casing pipe. Be aware that a minimum well casing pipe diameter of 4 inches is required by NR 812.13(1)(a)2. for potable high capacity, school and wastewater treatment plant wells in unconsolidated formations.

- The minimum casing diameter for a newly constructed consolidated bedrock wells is 6 inches (NR 812.14).
- According to NR 812.13(2)(b) and 812.14(3)(c), the minimum diameter for the upper enlarged drillhole for potable high capacity, school and wastewater treatment plant wells is 3 inches larger in diameter than the outside diameter of the well casing pipe or the outside diameter of the well casing pipe couplings, if used.

- **Casing depth:** Minimum well casing pipe depth requirements for wells serving NN systems that are the same as private or non-community water system wells are provided in NR 812.13, 812.14, 812.15 and 812.42(1)(b). However, for potable high capacity and school wells, a minimum casing depth of 60 feet below the ground surface or 20 feet below the static water level is required, whichever is greater, according to NR 812.13(1)(b)2. and 812.14(1).

- **Casing height:** Verify the current casing height with a tape measure. In most instances, the casing height should be 12 or more inches above the established ground surface, or the floor of an enclosure/pit/ pumphouse.
  - Wells constructed indoors (alcove, pit or basement) before 1953 only had to be 6 inches minimum above the surrounding ground surface. Additional guidance on this matter can be viewed in the DNR handout titled *Pits and Alcoves - A fact sheet for drillers and pump installers PUB-DG-085 2017*.
  - Between 1953 and 1991, well casings installed outdoors were required to be at least 8 inches above the surrounding ground surface.
  - All wells constructed since April of 1991 have had to be at least 12 inches above the surrounding ground surface.
  - According to NR 812.42(11)(c), well casing height greater or equal to 8 inches installed before February 1, 1991 meets the requirements of the code at the time it was installed and is not required to be extended to meet the current code. Additional guidance on this matter can be viewed in the DNR handout titled, *Well Casing Heights - A fact sheet for drillers and pump installers PUB-DG-089 2017*.
  - Currently, the well casing pipe may not terminate in or extend through the basement or crawl space of a building but may terminate in a walkout basement if the conditions of NR 812.29 are met or may terminate in an existing alcove if it complies with NR 812.42(2).
  - All high capacity, school and wastewater treatment plant wells shall terminate at least 12 inches above established ground grade per NR 812.42(7)(a)2.
  - Wells located in a floodplain (includes floodfringe or floodway) must terminate at least two feet above the regional flood elevation according to NR 812.42(7)(a)4.
  - In order to comply with NR 812.36(3)(b)3., wells installed in driveway ramps shall have a minimum of 4 inches of casing height above the original grade of the driveway, parking lot or sidewalk.
  - The poured concrete floor of an above ground pumphouse must be 4 inches above the surrounding grade according to NR 812.40(1). The well casing must meet the corresponding well height requirements above the concrete floor level.

- Wells can be reconstructed or replaced in a floodway or floodfringe but a new well cannot be constructed unless one previously existed in the floodway or floodfringe as provided by NR 812.08(3).

D. Special requirements

- If a well construction report exists, the well casing depth should be compared to both the current well construction requirements and those that were in place at the time the well was constructed. Refer to NR 812, Tables I & II for low capacity wells and Tables III & IV for high capacity, school and wastewater treatment plant wells. Generally, low capacity wells constructed in unconsolidated formations must have a minimum of 25 feet of casing or 10 feet below the static water level, whichever is deeper, according to NR 812.42(1)(b)4. Bedrock wells in dolomite or granite typically require 40 feet of casing and 30 feet for bedrock wells in sandstone. As noted in the casing depth paragraph above, high capacity and school wells must have a minimum of 60 feet of casing with a 3-inch annular space. Site-specific geology is a consideration for every well.

- The water supply specialist completing the sanitary survey should also review any available well construction information to ensure the well is not a "dual" aquifer well. For example, this situation can occur in the eastern part of the state where the Silurian dolomite and St. Peter sandstone aquifers are occasionally separated by a relatively impermeable layer of Maquoketa shale. A well may be completed either into the dolomite or the sandstone but shall not be open to both aquifers. The head differential between the aquifers can allow rapid contaminant movement negating the protection provided by the impermeable layer. Dual aquifer wells must be backfilled or lined to isolate the two aquifers. This is described in NR 812.14(1)(j).

- The water supply specialist completing the sanitary survey should also note if the well is located in a special well casing depth area and determine whether or not the well complies with the construction requirements in place when the well was constructed. Special well casing depth information can be viewed using the Well Driller Viewer.

- While not encountered often, it is important to note that additional casing is required for wells constructed within 500 feet of a quarry, based on the existing or proposed quarry floor. This is provided in NR 812.12(16).

E. Grouting and packing

- Wells shall be grouted using neat cement grout (or other approved annular space sealing material) according to NR 812.20. Documentation can be provided according to NR 812.42(1) to indicate the well is grouted.

- A sodium bentonite water slurry (drilling mud and cuttings) may be used as sealing material in unconsolidated formation wells or bedrock wells, provided depth to a bedrock formation or other well construction requirements in Tables I

to IV (NR 812) do not specify only use of neat cement grout and the well is not a potable high capacity, school or wastewater treatment plant well.

- Neat cement grout shall be used to seal the annular space as stated in NR 812.20:
  - of low capacity wells when the upper enlarged drillhole is constructed more than 5 feet into a bedrock formation,
  - of low capacity bedrock wells when bedrock is encountered within 40 feet of the ground surface or within 30 feet of the ground surface if the bedrock is sandstone,
  - of potable high capacity wells,
  - of school wells,
  - of wastewater treatment plant wells, or
  - when a liner pipe is installed for the purpose of preventing water containing contaminants with levels exceeding the drinking water standards of NR 812.06 from entering the well.

- Grout openings or voids may be created around the casing during the drilling process. The grout acts as a seal to prevent contamination from moving down the casing to groundwater and also stabilizes the formation and protects 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.

F. Screen

A screen is attached to the lower end of the well casing in some formations according to NR 812.13(1)(e). An adequate screen can prevent sand pumping conditions in unconsolidated formations.

Small stone or gravel, commonly referred to as gravel pack, is often installed around the screen and part of the well casing pipe. The gravel pack allows water to freely enter the well during pumping, but it prevents the sand formation from entering the well.

The well screen should be constructed of corrosion resistant material that is both strong and hydraulically efficient. The screen's mesh size should be determined based on a sieve analysis of the formation or gravel pack materials. The screen should be installed so the pumping water level remains above the screen under all operating conditions.

For potable low capacity wells, a continuous-slot screen shall be composed of stainless steel, everdur, monel, brass or approved PVC according to NR 812.16(3)(b). Noncontinuous-slot screens may be used if approved. For potable high capacity wells, a continuous-slot screen, v-shaped, wire-wrap on a rod base type; composed of stainless steel, everdur, monel or brass shall be used according to NR 812.16(3)(a). Current code states that the brass in a well screen may not have a lead content of more than 8 percent as noted in NR 812.13. It is worth noting that packers containing a high percentage of lead have been used to connect the well screen to the casing pipe in the past.

G. Well caps and seals

Wells shall be sealed or covered with an approved weather and vermin-proof compression type well cap or seal installed on or in the top of the well casing pipe. This is provided in NR 812.30 and 812.42(8). Survey staff should not remove a well cap or seal from a well casing during a sanitary survey.

- **Seal type:** Approved sanitary well seals may be used to used to cover the upper well terminal according to NR 812.30(2) and 812.42(8). Sanitary well seals may be a full plate well seal or a split top plate seal. According to NR 812.30(2), a split top plate seal may not be used unless the well is enclosed in a substantial, permanent weather-proof shelter meeting the requirements of NR 812.40.

- **Overlapping caps:** Overlapping caps were allowed to be installed before 1991. After 1991, overlapping caps were not allowed. If a NN system has a pre-1991 overlapping cap, specialists should recommend it be replaced with an approved vermin-proof cap or well seal. If an overlapping cap fails or if it is removed so that well or pump work can be completed, the overlapping cap shall be replaced with a vermin-proof or other code complying cap or seal per NR 812.42(8)(d).

- **Vermin-proof cap:** According to NR 812.30(1), new wells, those constructed after the February 1, 1991 effective date, shall be sealed or covered with an approved weather and vermin-proof compression type well caps or seal installed on or in the top of the well casing pipe. NR 812.42(8)(d) states that no open holes, other than the well vent, may exist in the cap or seal. Most vermin-proof caps are designed so the lower part of the cap is bolted to the well casing pipe, the upper part of the cap is bolted to the lower part of the cap and a rubberized gasket is seated between the upper and lower part of the cap. Many vermin-proof well caps have a built-in, downward-facing, screened well vent.

- **Well vent:** A screened, downward-facing well vent or other vent (e.g., mushroom-style vent) may be provided for the well cap or seal for drilled wells as stated in NR 812.30(3). Well vents are no longer required by code. However, well vents do prevent a vacuum from being created as water is lifted out of a well, which could impact pump operation. The vent opening may be plugged watertight with a threaded plug as allowed by NR 812.30(3) when the well is a flowing well in order to keep the well cap or seal watertight or when there is concern for air-entrained bacteria to enter the well through the vent.

- **Vent pipes:** Vent pipes extending above the well casing pipe shall terminate in a downturned bend and shall be screened according to NR 812.30(3). This code section also notes that screens shall be made of material that is not easily corroded and firmly seated in the vent opening along with that vent openings incorporated as part of the underside of an approved well cap or seal are allowed.

- **Electrical conduit:** Where electrical wiring emerges from an underground installation to supply well pump equipment, it shall be protected from physical damage by installing conductors or cables within a nonmetallic or steel raceway.

The conduit shall be threaded tightly into the well cap or shall be secured and sealed in an equivalent manner. Where a direct buried electrical cable supplies the well, the bottom of the conduit providing physical protection shall extend a minimum of 2 feet below grade. The conduit shall be sealed above grade in a watertight manner with a listed fitting, or by use of 100 percent silicone, urethane or Butyl caulking. The requirements above are provided in NR 812.30(5).

H. Types of well discharge

- **Above-ground discharge:** Frequently referred to as an "over-the-top" discharge, an above-ground well discharge is required for school and high capacity well applications according to NR 812.31(2)(c). This code section provides conditions when an approved pitless unit/adapter is allowed for a school or high capacity well. NR 812.31(2)(d) also requires the use of an above-ground well discharge for crystalline (granite) bedrock wells approved for installation of 25 or less feet of well casing pipe. Pump installations provided with an above−ground discharge must meet the minimum requirements of NR 812.32(1)(a), (5), (6) and (7). Above-ground well discharges may be in one of the following configurations.
    - Discharge pipe remains above ground - the entire discharge pipe from the well is located above ground between the wellhead and the first storage device. Surveyors may observe a vent on the discharge line from the well in locations where the discharge pipe is not located in a heated enclosure. This vent allows water in the discharge line to flow back into the well to prevent water from freezing within the discharge line.
    - Discharge pipe is buried - the discharge pipe from the well goes below the ground surface between the wellhead and the first storage device.
    - Morrison well tank water system - this is an older manufactured product that may be encountered during a sanitary survey. Water from the well discharges above ground and goes to a buried air over water pressure tank located adjacent to the well casing. Water leaves the pressure tank below ground through a pitless adapter seal. These systems are specifically worth noting because it may be difficult to determine if the tank is leaking and there are unique challenges associated with fully disinfecting the system. DNR staff should generally recommend these systems be replaced when feasible. Replacement should be required if total coliform negative samples cannot be obtained.

- **Below ground discharge:** It is critical to note that buried discharge lines from submersible pumps shall meet the requirements of NR 812.28, and shall be maintained under system pressure at all times as stated in NR 812.32(4)(a). In order to maintain system pressure at all times, check valves may not be placed in the pump discharge pipe in or beyond a buried section of discharge pipe between the well and the first storage device. Wells encountered during a sanitary survey of a NN system may have one of several types of subsurface discharges.
    - Pitless adapter - a pipe lateral welded over a cutout section of the protective well casing pipe below grade. These units shall be installed according to the requirements of NR 812.31.

- Manufactured pitless unit - a pitless adapter factory−welded to a section of steel well casing pipe for a factory−assembled pitless unit rather than welded by a well driller or pump installer in the field. These units shall be installed according to the requirements of NR 812.31.
- Spool adapter - a spool adapter is a manufactured product that is used to transfer water from the drop pipe to a buried discharge line. Spool adapters are present in many older installations but are not installed often today. The reason is that the spool often gets hung up within the well casing pipe. This can make it challenging for a pump installer to remove and reinsert the drop pipe and pump from a well with a spool adapter. One application where spool adapters are still installed is PVC spool adapters for wells constructed with PVC well casing pipe. Spool adapters shall be installed according to the requirements of NR 812.31.
- Pitless receiver tank - a pitless unit having a permanently attached steel pressure tank encircling the casing pipe that is assembled as one complete unit in a factory. Also referred to as a pitless adapter tank. Planned replacement of these tanks should be recommended because it may be difficult to determine if the tank is leaking and there are challenges associated with fully disinfecting the unit. Pitless receiver tanks shall meet the requirements of NR 812.31(5).
- Pressurized conduit - unprotected buried suction lines or suction lines enclosed in non-pressure conduits may not be used. The pipe for a pressurized conduit shall meet the requirements of Table V in NR 812, and shall enter the basement such that any pump suction pipe in the basement not enclosed in a pressurized conduit shall be at least 6 inches above the basement floor as stated in NR 812.42(6). The DNR recommends the pump impeller or cylinder of pump units be located in basements not subject to flooding and be at least one foot above the floor.

2.2.7(b) Pumps / Pump Controls, Facilities, Pipe and Pipe Appurtenances

Definition: A review of pumps and pumping operations that are used to transport water for consumption from a source to the storage, treatment and distribution sections of a complete water supply system.

Objectives: Staff should verify pumps/pump controls, facilities, piping and pipe appurtenances meet code requirements at NN water systems. As noted in subsection 2.2.7(a) of the operations handbook, approvals are required for the construction, reconstruction and operation of all school and wastewater treatment facility systems and for the construction and operation of high capacity well systems. Pump applications also include chemical feed systems.

While observing the pumping operations of a water system during a sanitary survey, the identification of various types of water supply pumps, their appropriate uses, and their associated components are to be noted. Also, to recognize deficiencies associated with the physical facilities (if any) of which include; the pump itself, pump control equipment, pumping rates, appurtenances and stand-by power systems. All pump applications should be verified with any approvals that have been granted.

Applicable Wisconsin Administrative Codes for Pumps / Pump Controls, Facilities, Pipe and Pipe Appurtenances:

- NR 810 – pump maintenance (NR 810.13) and operational monitoring requirements (NR 810.07).

- NR 812 – pump installation equipment and supply pipe (NR 812.28), pump requirements (NR 812.32) and existing pump installations (NR 812.42).

- SPS 381, 382 and 384 – plumbing requirements related to installation of a chemical feed pump.

1. Water Supply Pumps / Pump Controls

A. Pre-survey considerations

Before going in the field, survey staff should obtain information on all water supply pumping applications noted during the last site visit (sanitary survey, level 2 assessment, compliance verification, etc.). This information would include product information along with the installation date and when it was last inspected or replaced.

B. Pump information and specifications

Note the current pump make/model, pump type, pump size, pumping capacity, pumping rate, pump setting (depth), the type of controller used (pressure switch or variable frequency drive) and if known, the drop pipe length (diameter and material). Newer pump systems may have variable speed drive (pump controller) units which can produce higher pumping rates than are approved. If there is concern that the actual pumping rate may exceed the approved pumping rate, the actual pumping rate can be checked against the approved pump rate for compliance. The capacity of a well pump is sometimes listed on the motor plate along with the horsepower, motor speed and other pertinent information. Survey staff should note the capacity or other information provided on each pump and compare this information to the approved design for the pump.

The DNR recommends the well pump be inspected by a licensed pump installer once every 10 years, but the system might have a documented, established schedule or maintenance plan in place (NR 810.13(1)(a)).

If an air line is installed, ensure the opening through the well cap or seal is sealed completely, with an altitude gauge or other means of measuring the water level. This is especially applicable for required high capacity well water use reporting or pump volumes. See NR 812.39 for complete details.

A downward-facing, screened well vent shall be installed in the pump base of lineshaft turbine pumps as provided in NR 812.30(3) and 812.32(6).

Make note of the pump motor’s electrical supply condition and protection from flooding and potential contamination sources. All well pump electrical installations shall conform to the Wisconsin electrical code, incorporated by reference in SPS 316 and the requirements specified in that chapter. Ensure all electrical conduits are properly sealed to prevent possible contamination entry into the well. The electrical conduit for a pump

motor must extend continuously at least 2 feet below grade and sealed into the well cap as specified in NR 812.30(5).

Survey staff should note the type of pump discharge (above-ground, pitless adapter, spool adapter or an approved pitless unit). As mentioned in the Source section above, a pitless adapter is a lateral pipe which is welded over a cut section of the protective casing whereas a pitless unit is a manufactured lateral piping tee that is either threaded to the protective casing or welded to the end of the protective casing.

Survey staff should note the piping schematic of each well pump and if interconnected, note any backflow prevention between the pumps including air gaps, additional check valves, reduced pressure zone (RPZ) backflow prevention assemblies and electric actuator valves.

There are special requirements for pumps located in subsurface pump rooms, alcoves, or pits (NR 812.36 and 812.42).

C. Types of water supply pumps

- Submersible well pumps are placed inside a well to lift water out of a well. This is done by impellers inside the submersible well pump that spin within what is referred to as the “liquid end” of the pump. The impellers are driven by a submersible pump motor. There are two types of submersible pump motors. A 3-wire motor requires a control box with a starting capacitor located outside of the well. A 2-wire motor does not need a control box because there is no starting capacitor. Instead, a 2-wire motor has a built-in electrical device that is used to get the motor started. In most instances, submersible pumps cannot be inspected during the sanitary survey because they are inside the well. It is becoming more common for pump information to be displayed on the starting capacitor box for pumps with 3-wire motors for future reference. Survey staff may talk with the system representative or pump installer to obtain more information for well pumps with 3-wire motors for which this information is not visibly displayed as clearly as for pumps with 2-wire pump motors.

- Vertical turbine well pumps use an electric motor on a pump base to turn impellers within bowl assemblies on the bottom of a shaft. Water in the well is lifted through the column pipe and is discharged from the well above ground through the discharge flange. The following points about vertical turbine pumps should be noted.
    - Well pumps are required to be water lubricated unless oil lubricated pumps are needed to keep positive lubrication or if the static water level is low. Water lubricated pumps will have a pre-lubrication line unless the static water level is high enough that pre-lubrication is not needed. If not apparent, ask the system representative what type of liquid is used to lubricate the pump. NR 812.32(5)(b)3. states only food grade lubricant oil or coolant oil (USDA or FDA approved) is allowed for oil-lubed vertical turbine pumps.
    - Take note of the turbine pump base height above the pumphouse floor (at least 12 inches), the height of the protective casing above the pump base (at least one inch) and whether a well vent is present extending through the

pump base.

- Offset pumps: The condition of offset pumps (shallow or deep-well jet pumps) can be visually checked. Shallow well jet pumps, or suction pumps, use centrifugal force to draw water out of a well. This is similar to sucking water through a straw. Deep well jet pumps use both suction at the jet to bring water into the piping and pressure applied by the impeller to lift water in the piping out of the well. Offset pumps should also be the correct height to protect from flooding:
  - ≥ 12 inches (above a basement or pit floor) if installed after 1991 per NR 812.32(2),
  - ≥ 6 inches (above a basement or pit floor) if installed before 1991 per NR 812.32(2), and
  - Recommend 12 inches above ground elevation.

- Flowing well pumps and pump appurtenances: Flowing wells can only have underground pipe connections when used with an approved pitless adapter. Overflow piping is required to be screened and have a throttling valve (NR 812.32(9)). Illustrations of complying pump installations for flowing wells are displayed in NR 812.

- Booster pumps (including low-lift or high-lift pumps): Determine the horsepower, pumping rate (gallons per minute) and average runtime. Check to make sure the water system provides a way to determine low and high-water levels (pump on / pump off) for any water storage vessels (reservoir, standpipe or elevated tank).

- Hand Pumps: Hand pump heads shall be designed and fabricated so there are no unprotected openings, other than the spout, to the interior of the hand pump. The water spout shall turn downward and be closed on top. If a separate watertight port is provided for priming, it shall be sealed watertight when not being used. Unsealed openings may not exist in the pump base. If the pump is installed outside, a concrete crack−free watertight pump platform at least 6 feet in diameter shall be provided. The top of this platform may be at ground grade, but in any case, the platform shall be mounded so that water does not accumulate around the well. If excess water flow from the pump spout is channelized, it shall be directed to a point at least 8 feet from the well with a drain pipe or watertight channel. The requirements above are stated in NR 812.32(7).

  Hand pumps shall be connected firmly to the well casing pipe by threading in small diameter well casing pipe or by bolting the pump base flange to a well casing pipe flange with a gasket to seal the top of the casing. NR 812.32(7). Other types of hand pump bases may be used if they meet the approval criteria in NR 812.30(1) for vermin−proof caps and seals.

D. Maintenance

During the survey, staff should ask if the system has a water supply pump maintenance program and how it is being implemented. Every public water system is required to perform regular maintenance to ensure proper operation of the water system as stated in NR 810.13.

E. Emergency power supply

Survey staff should inquire about any emergency power supply (dedicated onsite or offsite availability) to ensure continuous operation of water supply and chemical feed pumps. Generators, if used, are required to be exercised a minimum of once per month under normal load and quarterly under full load. Operators should document the dates and times of generator operation and maintenance and have those records available to survey staff. See NR 810.13(1)(d) for emergency power exercising requirements. Provisions should also be made by the water system to ensure an adequate amount of fuel is available prior to unplanned power outages.

2. Chemical Feed Pumps / Pump Controls

- Verify pump model, serial number, type (controlled-volume metering pump, peristaltic pump, etc.) and pumping rate (speed/stroke or percent) for each chemical.

- Ensure the chemical feed pump has an internal check valve or other means to prevent accidental chemical dosage. If not, an external check valve is needed.

- Confirm the chemical feed pump and pumping rate meet any corresponding DSPS or DNR treatment device or installation approval criteria required by NR 812.37.

- Ensure the chemical feed tubing is replaced according to the manufacturer's recommendations.

3. Pumping Facilities

Most "pumping facilities" at NN systems are inside the well but pump controls are usually located within the facility.

A. Types of pumping facilities

- "Dog houses" or "calf hutches": These facilities are typically wooden or fiberglass structures that cover just the wellhead but may be as large or larger than a well shelter especially ones with above ground discharge piping, a pressure tank, a heating element and possibly a dehumidifier. Most are secured to a concrete pad to prevent vandalism. They can vary in both size and shape.

- Well shelters: These facilities are usually permanent structures large enough to house only the wellhead and discharge piping. They are typically made of wood or brick.

- Pumphouses: These facilities may be large enough to house the well, a pressure tank and treatment devices. They are required to have an outward opening door when the structure is large enough, or a trapped floor drain discharging to the ground surface at least 8 feet from the well when a door is not installed. A hinged roof or removable hatch over the well, or some provision for pulling the pump is

also required. It is recommended security/safety lighting should be in working order. Above ground pumphouse requirements are provided in NR 812.40.

- Pits and subsurface pump rooms (alcoves): Survey staff may not enter any confined spaces. However, basement wells in walkout basements are considered safer and are not considered to be confined spaces. NR 812.07(114) defines "walkout basement" as a basement, with the floor at ground grade level on at least one side of the structure, from which it is possible to walk directly outside without walking upstairs or uphill.

B. Pump facility construction

Check for the following within pump facilities (if required):

- Weatherproof and freeze protection (if housing above ground discharge piping or pressure tanks) (NR 812.40(3))
- Varmint indicators (droppings, chew marks, nesting material, etc.)
- Proper drainage away from the well
- Secured access to separate buildings or rooms
- If constructed with a poured-concrete floor, the floor must be 4 inches above the surrounding grade, sloped away from the well or towards the door and have a watertight bond between the concrete and the well casing NR 812.40(1))
- Outward opening door or trapped floor drain discharging to the ground surface at least 8 feet from the well when a door is not installed (this does not include hinged or removable dog house-like shelters or manufactured well shelters) (812.40(2))
- A hinged, secured roof-accessible hatch or some other means for pump servicing (812.40(4))
- Storage of potential contaminant items (NR 812.40(5))
- A dehumidifier if used to address excessive condensation or moisture
- A heat source, if freezing is an issue (electric heater or heat tape controlled by a thermistor device) (NR 812.40(3))

C. Security (NR 810.23)

- Check for security fencing/lighting, secured windows and vents.
- If the well is enclosed in a permanent building, a secured roof hatch above the well pump for pump servicing shall be installed.
- For hinged or removable well shelters such as "dog houses," check to make sure the constructed unit is secured to prevent unauthorized well access.

D. Flood protection

- Verify location is outside floodplain/floodfringe as required by NR 812.08. This can be done based on local floodplain maps.
- Check the ground surface around well for drainage swales or direct surface water accumulation near the well or pump facility (NR 812.08(1)(b)).

4. Piping and Pipe Appurtenances

A. Pipe connections

- Pump discharge and supply piping shall conform to the specifications in NR 812.17 for steel pipe or shall conform to the requirements in the “Pipe and Tubing for water services and private water mains” table in SPS 384.30, except that Type M copper pipe may not be installed underground. Pipe used for year−round installations should be protected from freezing. Solders and fluxes containing in excess of 0.2% lead shall not be used according to SPS 384.40(4). The DNR recommends galvanized pipe not be used when the water quality is known to be corrosive.

- Limitations on the use of plastic pipe are found in SPS 384.30. Plastic pipe may not be used for buried pipe in soils known to be contaminated with volatile organic chemicals. Plastic pipe may be used as drop pipe installed within a well or for discharge piping between the well and the building served, provided it meets SPS 384.30, standards and has a minimum pressure rating of 150 pounds per square inch. (NR 812.28)

- Buried submersible pump discharge pipes connected to pitless units shall meet the requirements of NR 812.42(6)(a)3.

- For offset pump installations, any suction pipe shall be enclosed in a sealed pressurized conduit between the connection to the well casing pipe and a basement per. NR 812.32(2). NR 812.32(2)(a)5. mentions that offset pump installations shall be connected to the well with an approved factory−assembled pitless unit designed for and having a concentric pressurized piping arrangement.

- Buried suction lines must be under positive pressure or be protected with a pressurized concentric outer pipe (pressure conduit) according to NR 812.32. Buried discharge pipes from submersible pump installations are required to maintain positive pressure. Buried discharge pipes in jet pump installations are under negative pressure and if there is not a pressurized conduit surrounding it, contaminants are able to enter the water system. For a similar reason, check valves are not allowed upstream of the first storage vessel for buried submersible pump discharge lines. A check valve between the first water storage vessel and a well with a submersible pump can cause an increased risk of contamination in situations where pressure falls in the buried line before the pump kicks back on to fully repressurize the buried part of the discharge line.

- Unprotected buried suction lines or suction lines enclosed in non-pressure conduits may not be used. The pipe for a pressurized conduit shall meet the requirements of Table V in NR 812. The pipe shall enter the basement such that any pump suction pipe in the basement not enclosed in a pressurized conduit shall be at least 6 inches above the basement floor. The DNR recommends the pump impeller or cylinder of pump units be located in basements not subject to flooding and be at least 1 foot above the floor. These requirements are provided in NR 812.42(6).

B. Timers/controllers

Note model and type:

- Pressure switch
- Programmed
- Variable speed (controls motor frequency)

C. Gauges

Check for proper operation and condition:

- Liquid-filled
- Non-filled
- Altitude (for static vs. pumping water level - NR 812.39)

D. Meters

- Meter specifications: Determine what type of water meter is used and obtain associated product manufacturer information. High capacity wells are required to determine the volume of water withdrawn from the well on a monthly basis. An hour meter will not provide an accurate estimate of pumpage volume for wells that do not have a consistent output. The owner or operator of a high capacity well, or well system, must submit pumpage reports to the DNR on the appropriate forms at the time periods indicated by the DNR. Verify that this is taking place. Other NN systems may have a meter to determine water use for estimating wastewater discharged to a septic system, wastewater treatment system or sanitary sewer system for billing purposes. Details are provided in NR 820.13. High capacity wells must have a means to determine water levels as required by NR 812.39.

- Types of meters:
    - Analog
    - Digital
    - Remote read
    - Timed (i.e., hour meter will not accurately determine pumpage volume for well pumps controlled by a variable frequency drive or a cycle-stop valve on the discharge line).
    - Totalizing (measures actual water flow)

E. Valves

- Types of Valves: Take note of what type of valves are in the piping leading to distribution. Take an abundant amount of piping photographs from different angles to document the piping layout. Several types of valving include:

    - Check: A check valve is a flow-monitoring device typically used in pipeline systems to allow a fluid to flow in only one direction and prevent backflow or backwash. They can be used for a variety of fluid applications such as liquids, gases, condensate or slurries. An arrow on the side of the product typically indicates the direction of water flow.

- Air vacuum release: Allows excess air to leave the water system as well as lets air to re-enter the water system to prevent a vacuum, pipeline collapse or water column separation.
- Pressure reducing: lowers water pressure prior to certain uses such as a boiler system.
- Pressure actuated: opens and closes based on water system pressure.
- Gate: A gate valve has a flat closure element that slides into the flow stream to stop the fluid. They are one of the most commonly used valves and are primarily used to permit or prevent the flow of liquids. Gate valves can be used to throttle flow. There is no restriction to flow through the typical gate valve when the valve is in a fully open position. Gate valves can be used in demanding environments such as high-temperature and high-pressure environments. They are often used in:
    - Power plants
    - Water treatment
    - Mining
    - Offshore applications

  Gate valves are also known as knife valves, slide valves, sluice valves or linear motion valves.
- Ball: A round ball is located in inside a ball valve. The ball has a cylindrical hole through the center. Water flows through the ball when the valve is in the open position. The solid part of the ball stops water flow through the valve when the ball is in the closed position. Ball valves are used in situations where tight shut-off is required. They can also be used to throttle the flow through the valve.
- Butterfly: A butterfly valve is similar to a ball valve, but uses a rotating disk instead of a ball. It can be used to throttle flow like a ball valve. Unlike a ball valve, the disc is always present within the flow, so the each butterfly valves causes a drop in water system pressure, even when the valve is in a fully open position. They often cost less than other valve designs and are lighter in weight.
- Programmable: A programmable valve is a that can be set to open or close at certain times during a day.
- Cycle-stop: The cycle-stop valve (CSV) is an alternative to a variable frequency drive. They mechanically control the flow volume from a well without altering pump operation. They are commonly found at dairy farms. The function of a CSV is to:
    - Provide variable flow rates during steady pump operation,
    - Reduce the amount of water storage needed,
    - Provide minimum flow required to cool the pump and/or motor,
    - Provide minimum flow to replenish the pressure tank when, needed, and
    - Eliminate transient pressure waves and water hammer, stop line breaks.

2.2.7(c) Storage

Definition: Storage refers to water storage vessels and associated piping used to hold raw or finished water for later use and often to maintain water distribution system pressure. Although this may include storage of potable and nonpotable water, the focus during a public water

system sanitary survey specifically relates to storage of potable water.

Objective: Assess the condition of major components of potable water storage facilities in order to prevent water quality problems from arising during storage.

Applicable Wisconsin Administrative Codes relating to potable water storage:

- NR 810 – Operation & maintenance of water storage (NR 810.13 and 810.24)
- NR 812 – Water storage vessel requirements (NR 812.33 and 812.42)

1. Storage System Review

A. Storage information

Nearly all NN systems in Wisconsin have potable water storage. Obtain water storage vessel information for data entry in DWS. This includes the name of the vessel, location, vessel type (pressure tank, standpipe, reservoir or elevated tank), manufacturer, model, maximum storage volume in gallons, whether or not the vessel has auxiliary power and the date of last the interior inspection (if applicable).
Note that a list of common pressure tank models by manufacturer, including storage volumes, is routinely distributed to DG program staff. This list is also available on the DG SharePoint page. If available, note the firm pumping capacity, height to overflow and overflow elevation for nonpressure storage vessels. A schematic describing the nonpressure storage vessel may provide information that is not visible when looking at the vessel from the ground surface outside of the vessel.

NR 810.13 requires each water supplier for all public water systems to perform routine maintenance to ensure proper operation of the public water system. Ask the water system representative if there is a plan to ensure proper operation of its water system following failure of its water storage vessel(s). This becomes increasingly critical as vessel conditions may degrade over time. Potential contingency options may include using a temporary, emergency water source or shutting the water system down until the vessel can be repaired/replaced because the water system is inoperable.

B. Storage condition and sizing

Water storage vessels serving a NN system shall be evaluated for compliance with the applicable requirements provided in NR 812.33. Verify that the condition of storage components is acceptable, and that operation and maintenance of storage vessels is appropriate as required by NR 810.03.

Sizing requirements are not specified for water storage vessels serving non-community water systems. NR 812.33 simply states that the DNR recommends pressure tanks be sufficiently sized to provide the minimum pump run time recommended by the pump manufacturer. Typically, less storage volume is needed for systems with well pumps controlled by variable frequency drives compared to systems with traditional pressure switches.

During a sanitary survey, inspect water storage vessels for their acceptability for water storage based on their sanitary condition and other factors, as noted in NR 812.42(1). Specific evaluation criteria for existing ground storage reservoirs is provided in NR 812.42(4).

Water storage vessels are considered confined spaces. Only authorized individuals may enter confined spaces. DNR staff are not authorized to enter or climb on water storage vessels or associated ladders, etc.

C. Types of storage

There are two types of water storage vessels, pressure tanks and nonpressure storage vessels. At NN systems, pressure tanks are most the most common type of water storage vessel. Check pressure tank construction for compliance with NR 812.33(1). Pressure tanks come in many shapes and sizes. They are constructed in one of three ways: air-over-water, diaphragm or bladder pressure tanks.

An air-over-water tank is usually made of galvanized metal and often found in older buildings. These pressure tanks are not as popular as other types of pressure tanks for newer installations. Air-over-water tanks consist of a single chamber filled with both water and pressurized air with no physical barrier between the two. The pressurized air pushes on the water, providing the necessary water system pressure. These tanks are generally larger than most modern models, yet have a capacity similar to the smaller modern tanks. The single chamber design of these tanks makes them prone to becoming water-logged due to air loss through pin-hole corrosion.

Diaphragm pressure tanks consist of two separate chambers: one for compressed air and another for water. A rubber diaphragm is permanently attached to the sides of the tank, approximately two-thirds of the way up the tank, to separate water from air. The diaphragm rises and falls with the water level in the tank. As water enters the tank, the diaphragm is pushed up toward the compressed air chamber which then triggers a sensor to shut off the well pump. While efficient, these tanks can have problems with the diaphragm coming dislodged from the sides of the tank or folding over, causing water to flow into the compressed air chamber, which prevents pressure in the tank from increasing.

Similar to diaphragm pressure tanks, bladder pressure tanks utilize two separate chambers for compressed air and water. The bladder is a bag filled with water that acts like a balloon, that expands and contracts, triggering a sensor to activate the well pump. Air in the tank surrounds the bag and therefore water in the tank does not touch the interior walls of the tank. While a pressure tank bladder generally lasts longer than a pressure tank diaphragm and the pressure tank bladder does not have the risk of dislodging or folding over, pressure tanks with bladders may not be as good at lessening certain odors.

Nonpressure storage vessels are only present at a small percentage of NN systems. They are typically only installed at NN systems that regularly use a large volume of water or systems with low well yield. The large volume of water that can be contained in nonpressure storage vessels increases the volume of water available for the public water system at any given time. Standpipes, ground storage reservoirs and elevated storage tanks (water towers)

are the three types of nonpressure storage vessels that may be observed during a sanitary survey of a NN system per NR 812.33(2).

D. Pressure tank survey inspection

Inspect pressure tank(s) to make sure they are not corroded, leaking, damaged or waterlogged in order to ensure that the public water system is operated and maintained to provide an adequate quantity of safe drinking water to those consumers served by the supplier according to NR 810.03.

Corrosion (rust) can be a significant problem with metal pressure tanks subjected to warm and humid conditions. Humidity may be reduced by a dehumidifier if it is impacting a metal pressure tank.

Waterlogged pressure tanks are a common problem. This condition can sometimes be detected when the pump kicks on and off frequently, but pressure does not increase very much. Survey staff can check for failure of diaphragm or bladder tanks by depressing the air valve on the top of the tank. If water comes out, water is above diaphragm or outside the bladder. This is a visual indication that the tank has failed. It may be feasible for the water system to replace the internal components of certain tanks, especially larger tanks with access hatches. If the interior components of the tank are undamaged, air may be added to the tank. This can be done using a small air compressor on small or large pressure tanks. On large pressure tanks, an air compressor can be permanently installed to automatically add air to the tank as needed. An air compressor or other suitable means to add air to pressure tanks having a gross volume in excess of 500 gallons, and not having a water to air interface bladder, is required according to NR 812.33(1)(a)2.

Most pressure tanks at NN systems are located above ground or below ground in the basement of a building. However, a small percentage of pressure tanks at NN systems are located entirely below the ground surface. These tanks may either be completely buried or buried below the ground surface with one end of the tank extending through a basement wall. Buried pressure tanks are difficult to inspect during a sanitary survey because the entire tank is not visible. When pressure tanks are buried, any air unloader pipes or tank air valves shall extend at least 12 inches above grade per NR 812.33(1)(a)1.

A special type of buried, air over water pressure tank is associated with the Morrison well tank water system (a.k.a. Morrison head) called a pitless adapter tank. This system is described more fully in the NN sanitary survey source section of the operations handbook. Fewer and fewer pitless adapter tanks exist over time. Pitless adapter tanks are being replaced with other types of tanks when they fail because pitless adapter tanks are extremely difficult to effectively chlorinate.

A newer pressure tank design is the in-well pressure tank. These pressure tanks are installed as part of the pump column inside the well itself, preferably below the frost line. While use of in-well pressure tanks at NN systems has been limited so far, it is possible to encounter an in-well pressure tank during a sanitary survey of a NN system.

Occasionally a pressure tank is observed within the distribution system during a sanitary survey. It is worth noting that this tank may only provide additional water storage, like a large diameter water line, unless it is connected to a pressure switch for long piping runs from the

source. Any recommendations to remove such tanks should be carefully considered due to the fact that there may be one or more unanticipated benefits of having this tank installed within the distribution system.

E. Nonpressure storage vessel survey inspection

Nonpressure storage vessels installed after February of 1991 are required to comply with the construction specifications provided in NR 812.33(2), including that ground storage reservoirs must be above the groundwater level per NR 812.33(2)(b). Any reservoir shall be located so it can be kept in a sanitary condition as required by NR 812.08(1)(a) and protected from surface water flow and flooding per NR 812.08(1)(b). In addition, ensure ground storage reservoirs comply with the minimum separating distances provided in NR 812.08(4). All reservoirs shall be maintained in a sanitary condition per NR 812.42(4)(h). The draft *Nonpressure Storage Vessel Field Inspection Report* (Form 3300-305A) may be a useful reference for staff inspecting nonpressure storage vessels during sanitary surveys.

Surge tanks are also considered nonpressure storage vessels. Surge tanks are required to comply with NR 812.33(2)(a). A surge tank is a tank into which overflow from a flowing well, spring or other water source is discharged and is repumped to a pressure tank or the water system.

Verify with system representatives that reservoir hatches and buildings where smaller storage vessels are located are locked according to NR 810.23(1). Note any signs of unauthorized access. Additional water system security measures are provided in NR 810.23. Ask if there have there been any incidents at the system's storage facilities where site security was breached, accidents occurred or water quality was compromised.

2. Water Storage Approvals

A. Pressure tank installation approval

DNR approval is required for individual pressure tanks larger than 1,000 gallons gross volume. This approval is currently required by NR 812.33(1)(b). It was first required by NR 112.09(4)(p), effective February 1991, which was the well code that preceded NR 812. Code. Any pressure tank observed during a sanitary survey that is larger than 1,000 gallons and was installed after 1991 without approval will be considered a significant deficiency. In this case, ask the system representative to submit an after-the-fact (ATF) review request to DG's plan review section if the water system representative wants to keep using the unapproved tank. This request can be made by submitting a completed *Public Water System Approval Request* (Form 3300-260) and *Pressure Tank Submittal Checklist* (Form 3300-299).

If installed prior to 1991, ensure the pressure tank construction complies with the code requirements effective on the date the tank was installed. Requirements for existing installations are provided in NR 812.42. If needed, plan review section staff or field engineers may serve as a resource for this determination.

B. Nonpressure storage tank installation approval

DNR approval is required prior to installation of a nonpressure storage tank (i.e., standpipe,

ground storage reservoir or water tower) of any size. This approval is currently required by NR 812.33(2). This was first required by NR 112.33(2), effective February 1991. The prior approval requirement does not apply to surge tanks, which is noted in NR 812.33(2).

Any standpipes, ground storage reservoirs or water towers observed during a sanitary survey that were installed after 1991 without approval should be considered a significant deficiency. In this case, ask the system representative to submit an ATF review request to DG's plan review section if the water system representative wants to keep using the unapproved tank. This request can be made by submitting a completed *Public Water System Approval Request* (Form 3300-260).

If installed prior to 1991, ensure that the construction complies with the code requirements in place on the date tank installation was completed. Plan review section staff or field engineers may serve as a resource for this determination.

C. Nonpressure storage vessel modification approval

Inform the water system representative that DNR approval is required prior to beginning any nonpressure storage vessel modifications. DNR approval may be requested by submitting a completed Public Water System Approval Request for the proposed work to the DG plan review staff. Plan review staff will review this request for the proposed action(s), including making sure any paint or coating systems comply with American Water Works Association (AWWA) standard D102 and are National Sanitation Foundation (NSF) approved for use with potable water as required by NR 812.33(3). Ask the water system representative to inform the water supply specialist assigned to the system before the nonpressure storage vessel is inspected. NR 810.14(3) requires that the department's regional drinking water staff person shall be given 48 hours prior notice of the date and time of the inspection.

3. Storage Maintenance

A. Flushing and interior inspection

Verify pressure tanks are flushed regularly to remove sediment as required by NR 810.13(1)(e). Record keeping is required to be established by NR 810.13 to ensure proper scheduling as required.

Confirm that pressure tanks with hatches are inspected at least once every five years. These activities are required by NR 810.13(1)(e). It may be appropriate to review documentation of these actions during the sanitary survey. Survey staff may suggest system representatives refer to the *Water Storage Facility Inspection Report* (Form 3300-248). Although this report was developed for community water systems, it may provide good reference information for the system owner, operator or water storage facility inspector.

Confirm the water system is performing exterior inspections of vent and overflow screens and hatches at least once per year per NR 810.14(1). The water system should be documenting these inspections have been completed and note any follow-up actions taken.

Verify the water system will inspect any water storage facilities (includes vented ground storage reservoirs, water towers and standpipes) at the required frequency, currently once every five years, by appropriate individuals using the methods described in NR 810.14.

Confirm that inspection documentation has been submitted to the DNR for all inspections completed since the last sanitary survey, as required by NR 810.14(4).

Inspection reports should document the condition of each storage facility that was inspected. Also confirm that the water supplier has submitted copies of any additional reports or videos prepared by the inspector as required by code. Many of the potential contamination sources are difficult to assess without a recent inspection report.

B. Disinfection

When applicable, discuss the process for disinfecting and sampling prior to returning a nonpressure storage vessel to service after inspections have been completed. The specific requirements depend on the type of inspection that is completed. The corresponding requirements are provided in NR 810.14(2)(a) - (d). Be sure to inform water system representatives that in no case should water with a measurable total residual chlorine content be discharged to surface water without specific approval according to NR 810.19. Discharge of water containing chlorine is regulated by the DNR's wastewater program under Wis. Stat. § 283.31(1). Direct any questions or concerns to DNR's wastewater program staff.

C. Common sanitary issues

Common problems with nonpressure storage vessels include missing vent or overflow screens, corroded vent or overflow screens, deterioration of paint and steel structures, and cracks in ground storage reservoirs. All of these issues may lead to contamination of a water system.

Accumulated sediment can harbor bacteria that have entered a water system and may also serve as habitat in which these bacteria are able to multiply. Accumulated sediment also reduces storage volume, makes it more difficult to observe tank problems and reduces the effectiveness of disinfection.

For nonpressure storage vessels, items identified as needing correction during sanitary surveys should only address matters related to sanitary conditions. They should not address safety concerns that would not impact water quality. For example, corrective action should not be required during a sanitary survey for issues related to ladder or railing features.

4. Reference Material

Reference material for specific aspects of water storage vessels may be found in the municipal water system sanitary survey section of the operations handbook. However, please note that requirements contained in NR 811.61 - 811.66 apply to municipal and other-than-municipal community water systems, and therefore, cannot be enforced at NN systems.

2.2.7(d) Treatment

Definition: The purpose of water treatment is to condition, modify or remove undesirable impurities, contaminants or microorganisms from the raw source water. When treatment is required, it is generally used to provide water that meets primary drinking water standards. Water that meets primary drinking water standards may also be treated to make it more

palatable and acceptable to consumers. Installation of water treatment shall supplement and not replace proper well location, construction and water supply protection according to NR 812.37(2)(f).

Objectives:

- To review key components of water treatment processes such as chemical feed systems (e.g. those used for disinfection or sequestration purposes), as well as physical or mechanical treatment components (e.g. those used for filtration and sedimentation purposes).

- To document regulatory deficiencies of the water treatment processes and equipment related to the construction, operation, maintenance or managerial portions of the water supply system (i.e. chemical feed locations and/or storage).

- To identify safety issues that affect water system operations and the ability of water system staff to administer treatment effectively and efficiently.

- To determine regulatory compliance of each specific treatment process in the event of water quality changes to source water and/or within the water system (i.e. newly confirmed presence of coliform bacteria).

Applicable Wisconsin Administrative Codes for water treatment at NN water systems:

- NR 809, Subchapter II – corrosion control; Subchapter III – disinfection by-products

- NR 810.09 – general treatment and disinfection

- NR 812.37 – water treatment

- SPS 382 – design, construction, installation, supervision, maintenance and inspection of plumbing

- SPS 384 – plumbing products

1. Treatment Requirements

A. Treatment inventory

Evaluate treatment devices requiring installation approval during each sanitary survey to make sure approval conditions and applicable code requirements are met. This would include adequate chemical measurement capability, model/type of approved treatment device, use of NSF 60 certified chemicals and feed equipment with back-siphonage protection. Ensure treatment devices for regulated contaminants and aesthetic issues are properly maintained (particulate filters changed, softener brine replenished, tanks cleaned, etc.). Following a consistent maintenance schedule and keeping a maintenance log is recommended. Be aware that treatment devices previously installed for aesthetic treatment (such as water softeners or chlorination) may also reduce regulated contaminants such as arsenic, barium, etc. and should continue to be maintained and operated. Inconsistent use of aesthetic water treatment systems

can alter finished water quality and impact primary contaminant concentrations. Note on the sanitary survey if treatment devices have been removed, installed or have been bypassed since the last survey and notify the Public Water Supply Section Chief for further action.

All whole-system treatment devices, also known as point-of-entry (POE) treatment, installed in a public water system, regardless of their purpose, should be noted in the treatment section of the DWS. Also, include any point-of-use (POU) treatment devices used for non-primary contaminant control observed in the system in a general comment associated with the treatment screen of the DWS or in the comment field of one of the treatment processes. This would include adding "no treatment" on the treatment screen in the DWS (contact your EnPA for assistance). Information to enter for POU treatment devices would include the type of treatment device, model number (if known), date installed or put into service and what the device is treating. This aids staff in troubleshooting procedures when problems arise (i.e. particle filter not maintained while connected to the system).

B. Treatment approval

When public water system sample results indicate an exceedance of the maximum contaminant level (MCL) for one or more applicable primary regulated contaminants listed in NR 809, the water system is no longer in compliance. Once this occurs, water systems must investigate options for returning to compliance (i.e. reducing primary contaminate levels to below the MCL). This might include constructing a new well, reconstructing an existing well, connecting to an alternate source of water or installing treatment to resolve the problem. The return to compliance process is typically formalized through a consent order. In the consent order, a timeframe is established for the system to:

- evaluate and identify different corrective actions,
- propose the preferred corrective action to the DNR,
- allow for the DNR to evaluate and approve the proposed corrective action,
- allow time for the system to obtain DSPS approval (if appropriate) for the treatment device installation,
- fully implement the selected corrective action (may be installation of treatment), and
- return to compliance.

If a water system is unable to identify an alternate water source that meets safe drinking water standards, then installing treatment is the only option to reduce primary contaminant levels in their drinking water. Treatment in lieu of an alternate water source as required by NR 812.37 must be approved before installation.

Treatment devices installed at non-community systems to control one or more primary regulated contaminants need site specific approval prior to installation (NR 812.37(3)). Treatment *devices* (not the installation) already approved by DSPS can be found on the following webpage: alphabetical list of water contaminants with links to approved water treatment devices [Exit DNR].

The only type of treatment installation that is not reviewed and approved by DSPS is under NR 812.37(3)(b), a water treatment device to be installed on or within the well (resulting in treatment occurring within the well). An example of this type of treatment

would include disinfection installed in the well, such as a pellet chlorinator.

Water systems should contact DSPS directly for submittal materials and information about the overall submittal and approval process. It is possible that NN system owners/representatives will contact their DNR representative for help in navigating and understanding this process; it is recommended that DNR representatives become familiar with general DSPS processes (i.e. who to contact, what forms to use, what website to visit) so that they can direct water system representatives where to go when treatment installation is proposed.

Treatment systems used to remove secondary contaminants or to address taste and odor issues (referred to as aesthetic treatments) do not require formal DNR or DSPS approval. However, any treatment devices installed for treatment of secondary contaminants are required to be products or materials approved by DSPS according to a Memorandum of Understanding (MOU) between DSPS and DNR. An example of this type of treatment can include chlorination as a part of an iron removal process. If a water system intends to install such treatment, they should still contact their DNR representative and let them know that the treatment will be installed so that it can be added in DWS and confirmed that the intended use is for removal of a secondary or aesthetic contaminant.

The DNR may allow untreated water exceeding primary contaminant levels to be supplied for certain uses including, but not limited to; outside hose bibs, filling of swimming pools, fire protection systems, boilers used for space heating, turf sprinkler systems and non−food process water (e.g., non-contact cooling water).

2. Treatment Objectives and Treatment Identification

A. Reasons for treatment

The types of treatment processes and facilities used to achieve safe drinking water are dictated primarily by the quality of the source water and the regulatory requirements to be met. Groundwater systems may require treatment to comply with regulatory requirements (e.g.: coliform bacteria and *E. coli*; IOCs, including nitrate and nitrite; SOCs; VOCs; lead and copper; etc.) or aesthetic water quality contaminants (e.g., iron, manganese, color, and/or taste and odor).

Field staff should evaluate all water treatment processes in use at the water system during the sanitary survey. This evaluation should consider the design, operation, maintenance, management and approval of the water treatment to identify existing or potential sanitary risks. Water treatment is a primary means of preventing unacceptable drinking water quality from being delivered for public consumption. Treatment facilities and processes should help a water system meet any MCL or treatment technique requirements.

B. Groundwater rule and disinfection by-product rule

For groundwater systems, the regulatory requirements of the groundwater rule (GWR) and stage 2 disinfection by-product rule (DBPR) place additional demands on the treatment facilities. The GWR requirements are provided in NR 809.32, 809.323, 809.325, 809.327, 809.328, 809.329 and 809.35. The stage 2 DBPR requirements are

provided in NR 809.561, 809.563, 809.569, 809.60, 809.61, 809.62, 809.63, 809.64, 809.65 and 809.68. While some groundwater systems will be installing disinfection as a corrective action to comply with the GWR, those and other systems should be careful not to exceed stage 2 DBPR's locational TTHM and HAA5 MCLs as a result. Alternatively, groundwater systems with disinfection already in place that are having difficulty complying with the stage 2 DBPR should not make adjustments to their disinfection that result in an increased microbiological risk to consumers.

C. Treatment inspection and identification

Treatment facilities and processes should be evaluated to determine their ability to meet regulatory requirements and provide an adequate supply of safe drinking water at all times, including periods of high-water demand.

A sanitary survey of a NN system with water treatment should:

- Analyze all distinct parts of treatment processes, including, but not limited to, disinfection, chemical feed systems, hydraulics, controls and wastewater management.

- Identify features of the water treatment process that may pose a sanitary risk, such as inadequate treatment, monitoring/maintenance, lack of reliability and cross connections.

DNR staff may review and consider specific regulations or approvals that apply to the water system, its design criteria, records and past survey documentation that may identify previous compliance problems prior to performing the actual sanitary survey of the water system. The following sections discuss specific portions of common treatment processes that may be evaluated during a sanitary survey.

3. Treatment Site Plan

A drawing or site plan indicating the location of the treatment devices, the type(s) of treatment provided, and where any chemical injection points are located, will enable survey staff to obtain a quick understanding of the treatment methods. If possible, survey staff should review any drawings or site plans prior to the sanitary survey. See NR 812.37(4) for details.
Drawings or site plans should be dated to assist in identifying future changes to the water system. This information should be updated during each subsequent sanitary survey to reflect any water system changes.

4. Chemicals and Chemical Feed Systems

Chemical feed systems are common in many groundwater treatment facilities. These systems can be used to feed treatment chemicals such as disinfectants, oxidizers, corrosion inhibitors, pH adjustment chemicals, etc. The types of chemicals that are used depend on the specific treatment devices and the objectives of the treatment processes. Types of chemical feed systems may include liquid chemical feed, dry chemical feed and limited gaseous chemical feed. Refer to NR 812.37 for details on water treatment devices and control systems requiring product and/or installation approval from DNR and/or DSPS.

A. Types of chemical feed systems

- **Liquid chemical feed systems**
  A typical liquid chemical feed system would include:
  - A chemical solution tank, with sealed openings, to hold the chemical solution to be added
  - A chemical feed pump and suction line extended into the solution tank
  - A way to determine chemical dosage (e.g. scales, graduated containers, etc.)
  - A discharge line with an inline (or equipment-designed) check valve and an injection valve at the point of application (ensure the injection port is installed according to the manufacturer's recommendation)
  - A dedicated electrical outlet wired to the well pump operation in order to control the chemical pump operation so that the chemical feed pump is only energized when the well pump is actively operating

- **Dry chemical feeds (volumetric and gravimetric)**
  A typical dry chemical feed system (e.g. water softener) would include:
  - A volumetric means to determine the dosage of the dry chemical
  - A tank or solution chamber for mixing
  - A gravity discharge line to the point of application
  - A regeneration backflush wastewater discharge line, if applicable

- **Gaseous chemical feed**
  A typical gaseous (chlorine) feed system has these properties:
  - Since chlorine gas is considered a dangerous chemical, it is supplied in steel cylinders. In this form, it can only be added to water with special equipment and knowledge. Gaseous chemicals require special design considerations for storage, ventilation and application. Keep in mind:
  - Chlorine gas is typically a greenish-yellow color,
  - Chlorine gas is 2.5 times heavier than air,
  - Chlorine gas is corrosive to some metals, and
  - Gaseous chemicals are primarily used for disinfection purposes.

B. Assessment Criteria for Chemical Feed Systems

What chemicals are in use? Are those chemicals approved for use in drinking water?
Survey staff should inspect chemical containers and discuss with the operator what type of chemicals are used and their purpose. Survey staff should check that the chemicals in use carry the NSF or Underwriters Laboratories (UL) labeling to ensure the chemicals used conform to all applicable requirements of NSF Standard 60: Drinking Water Chemicals-Health Effects. Water supply systems may be using compounds or chemicals that are not approved for use in drinking water (e.g., household bleach or pool shock in place of NSF approved sodium hypochlorite). Survey staff may also check for NSF approved chemicals on the Water Quality Association's Certified Water Treatment Products [Exit DNR] webpage. Refer to NR 812.37(2)(i).

Are the treatment chemicals appropriate for the water system?

Survey staff should discuss with the owner/operator and assess whether the chemicals used in treating the water are appropriate. Water systems may purchase and use chemicals that are not appropriate for their treatment objectives.

Where is each chemical added in the water system?
Survey staff should examine chemical feed points and note where and how the chemicals are added, whether the feed points are active or for standby, whether the points of application are appropriate and whether the feed points allow for chemical compatibility. Some chemicals may counteract each other if not properly applied. For example, if the system was introducing an oxidant (chlorine) prior to the application of chemicals used for sequestration of iron and manganese, the chlorine would oxidize the iron and manganese before the sequestering chemicals could work to keep the iron and manganese soluble in the finished water. Some may produce health hazards if not properly applied, such as sodium hypochlorite and polyphosphates. As noted earlier, these points of chemical application should be noted on the system site plan or schematic.

As a general rule, the DNR representative completing the sanitary survey should know the application points and dosage of all chemicals used in the water system's treatment processes. The purpose of the chemicals should be understood so that the appropriateness of the feed locations and rates can be evaluated. This may require survey staff to perform research on the chemicals the water system uses either before or after the sanitary survey.

What type of chemical feed equipment is used? What is the condition of the chemical feed equipment? Is emergency chemical feed equipment available?
Survey staff should note the type of chemical feed equipment in use and its ability to feed chemicals on a continuous basis. The equipment should be functional and properly maintained. For example, with dry chemicals, survey staff should look for problems with "bridging" of the chemical during mixing in the storage tank. Liquid feed lines should be checked to see that they are not clogged. Recommend having redundant equipment on site of sufficient capacity to replace the largest chemical feed unit. Examine repair records and the system's supply of spare parts and/or redundant equipment. Discuss implementing or maintaining an existing preventative maintenance program.

Is the chemical feed equipment calibrated, and how does the operator determine the amount of chemicals used?
Calibration should be completed each time a new batch of chemicals is used. The feed equipment feed rate should be checked frequently. One method of checking is to use a graduated cylinder to verify the feed rate on a weekly or monthly basis (e.g. "pump catch").

Is backflow prevention provided on the water lines used for chemical feed makeup?
All lines supplying water for chemical feed makeup should be equipped with acceptable air gaps or appropriate backflow prevention devices to prevent cross connections which may lead to potential contamination of potable water.

What type of chemical storage facilities are provided? Is the storage area for each chemical adequate and safe? Is secondary containment provided? Are incompatible chemicals stored together?

The chemical storage area capacity should be adequate to allow space for unobstructed access for loading and unloading of chemicals. A minimum 30-day supply of chemicals is recommended. The bulk storage facility should have indicators for chemical storage levels. Solution tanks should have a convenient method for determining the amount of chemical in each container. The storage facility should have safeguards against accidental spills, and like every other treatment space, should have a clean water source under high pressure and a drain for effective cleaning and decontamination. In the case of some gaseous chemicals, like chlorine, special ventilation equipment and the availability of Occupational Safety and Health Administration (OSHA), approved breathing apparatus may be required. Breathing equipment and other personnel safety equipment and gear should be stored outside the storage area where the equipment can be safely accessed. Incompatible chemicals should be stored separately (e.g., gasoline for maintenance equipment should not be stored near water treatment chemicals, strong acids should not be stored near chlorites). The chemical storage and the storage facility itself should be located so as to not allow a chemical spill to reach the raw water source, the treated water or water being treated. In addition, every container in the storage area should be labeled and every storage area should be labeled to identify what chemicals are being stored in the storage area.

What is the condition of the building/room where the chemicals and chemical feed equipment are stored? Is adequate ventilation provided?
Survey staff should check to ensure that the interior of the building housing the chemicals is kept clean and dry. The general condition of the building housing the chemicals is an indicator of the maintenance standards at the facility. Spills of chemicals can cause hazardous conditions and/or increase corrosion within the building. Adequate ventilation, heating and air conditioning are important in maintaining the sanitary integrity of the building. Equipment used for controlling and removing dust and vapors should be functional and effective.

C. Disinfection

The practice of water disinfection has proven to be one of the most important and common advances in reducing the incidence of waterborne disease. In this regard, disinfection is an important corrective action alternative for the GWR. Disinfection is the process of destroying or inactivating microorganisms in water, with the probability that all pathogenic bacteria or viruses are destroyed or inactivated in the process. Two example types of disinfection are described below. A third example, ozonation, is typically only used in larger water systems such as municipal water supplies.

1. Chlorination

Basics
Chlorination is the most common disinfection method used by water systems in the United States, because of its proven effectiveness, low capital and operating costs and its established history in the water industry. Chlorination involves one of the three chemical feed processes described above. Free chlorine provides a high level of disinfection at the point of application and a measurable residual in the distribution system.

Dosage refers to the amount of a chemical fed into a volume of water. chlorinator.

For chlorine, this value is correctly calculated in milligrams per liter (mg/L). However, mg/L and parts per million (ppm) are generally interchangeable in water treatment calculations.

Demand refers to the dosage that is required to treat (or be consumed by) the contaminant. For instance, chlorine is a very active chemical oxidizing agent and combines readily with certain substances (e.g., hydrogen sulfide, ferrous iron, manganese, nitrite, organic impurities, and organic nitrogen compounds) that can be oxidized by chlorine. These reactions use or consume some of the chlorine. The amount that is used is called the chlorine demand. The reaction time between chlorine and most organic compounds is long (hours to days); therefore, the demand is based on time (i.e., the measurable demand at the end of 20 minutes is less than the measurable demand at the end of one hour of contact, due to the amount of time the chlorine has had to react with the organic compounds).

Residual is the amount of chlorine present in the water after a specified period of time and is measured in mg/L.
Chlorine demand (mg/L) = Chlorine dose (mg/L) - Chlorine residual (mg/L)

Assessment criteria for chlorine dosages and residuals

Does the operator understand the disinfection process?
The operator should be knowledgeable about the disinfection process and the equipment used to provide adequate disinfection treatment. The lack of knowledge by the operator of the disinfection process or the equipment can be an indicator that equipment failure or other problems may not be resolved in a timely manner. Attending appropriate classes to understand the disinfection process, or working with a third-party contractor, such as a Wisconsin Rural Water Association circuit rider, is highly recommended.

Have there been any interruptions in disinfection? If so, why?
Survey staff should assess if there were interruptions in disinfection and determine what steps have been taken or may be needed to prevent further interruptions.

What disinfectant residual is maintained?
Records of disinfection residuals in the treatment room and in the distribution system (if applicable) should be checked. In addition to verifying proper residual chlorine levels, determine if the equipment and testing methods are adequate.

Is the contact time between the point of disinfection and the first drinking water outlet (i.e. fixture) adequate?
As stated previously, contact time is the interval in minutes (T) that elapses between the time when chlorine is added to the water and the time when that same slug of water passes by the sampling point. A certain minimum period of time, depending on disinfectant residual concentration (C), water temperature and other factors, is required for completion of the disinfecting process. The requirements for contact time (T) and disinfectant residual concentration (C) depend on the pH, temperature and flow rate of the water. These records are

especially important if the system is required to meet the 4-log (99.99 percent) virus inactivation requirements of the GWR.

For systems determining CT, are the temperature and pH of the water at the point of chlorine application measured and recorded?
The CT value required for proper inactivation of viruses depends on the pH and temperature of the water. Therefore, some groundwater systems may be required to take these two measurements regularly and perform CT calculations at peak hourly flow. The pH should be measured with an approved meter, not with litmus paper or a colorimeter. The temperature should be measured with a calibrated thermometer.

Assessment criteria for liquid chlorine systems
Is the disinfectant chemical used appropriately certified?
Chemicals introduced into drinking water (even water softener salt) should be certified as meeting the standards of NSF 60 or an equivalent standard. This certification ensures that the chemical has been tested and found acceptable for use in public water supplies.

What is the strength of the chemical feed solution?
The strength of a chlorine solution should be known in order to achieve the proper dose of chlorine solution. Each operator should be familiar with procedures for preparing and testing the solution and determining the dosage.

Is chemical storage adequate and safe?
It is recommended that water systems have a 30-day supply of chemicals on hand to prevent running out of chemicals and losing disinfection capability. Hypochlorite is a strong oxidizer and should be kept away from any combustibles, especially petroleum products. Liquid storage is recommended to have spill containment around it. Proper safety equipment such as showers, eyewashes and respirators should be available.

Is equipment operated and maintained properly?
Failure of the feed equipment could result in loss of disinfection. Therefore, all equipment should be well maintained with a regular preventative maintenance schedule. Feed lines should be checked regularly to make sure they are not clogged. Clear plastic lines should be replaced if they become opaque.

Is standby equipment available?
If a chemical feed pump fails, the system can lose disinfection capabilities. Therefore, the system should have at least one backup chemical feed pump. If a valve fails, the system can lose disinfection capabilities. Therefore, a system should have adequate spare parts on hand to be able to quickly replace any valves in the chlorine feed system.

What is the pump model? Stroke and speed settings?
The operator should be familiar with the type and model of the chemical feed pumps. Chemical feed pumps generally have adjustable speed and stroke length that help to determine the feed rate. Speed and stroke length should be kept within the manufacturer’s specified ranges.

Where is the feed solution stored?
The feed solution should be stored in a clearly labeled, covered and chlorine resistant tank. It should be in a clean and dry area and have the appropriate spill containment surrounding it. Recommend containment if none is provided.

How is the chlorine feed solution prepared?
The operator should be familiar with the process for mixing the chlorine feed solution. Proper safety equipment should be used for preparing the solution including chemical resistant gloves and goggles.

Are stand-by or emergency chlorination processes appropriate?
If provided, stand-by and emergency chlorination treatment procedures should be evaluated. Determine if an appropriate injection port is installed. Ask how the system would obtain a fresh supply of chlorine to treat a 0.5 mg/L chlorine residual to the farthest point of the distribution system within 4 hours (e.g., on-call contractor or bulk delivery company).

Is the chlorine feed rate adjusted manually or automatically for flow?
Disinfectant feed rate should vary depending on flow rate. This can be done either by manually adjusting the chemical feed pump or by hooking the pump to a flow sensor that adjusts chemical feed pump rates in proportion to the measured flow rate in the pipe (flow-paced). Chemical feed pumps should not be turned on when there is no flow. The operator should be familiar with calculating the required chlorine dose based on flow and determining if the pumps are delivering a sufficient dose.

Are proper cross connection controls in place for the make-up water?
If finished water is used to provide water for chlorine injection, make-up water, or preparation of chlorine feed solutions, there should be proper cross connection controls to prevent backflow into the finished water lines. This means providing a sufficient air gap if a hose or faucet is used or installing the appropriate backflow prevention devices if the line is piped into the feed facility.

2. Ultraviolet (UV) light
Ultraviolet (UV) light treatment systems are safe, clean, easy to maintain and ensure bacteria-free water. A UV light water treatment system destroys almost 100 percent of the microorganisms that are harmful. These systems do not add chemicals or change the taste and odor of the water.

Basics
UV light has been used to disinfect water supplies for more than 75 years, but only recently have smaller UV systems become available. The primary advantage to UV treatment is that it disinfects water without the use of chemicals. Its primary disadvantage is the lack of residual disinfection.

UV treatment may either be point-of-use or point-of-entry. UV light is able to inactivate bacteria, viruses, Giardia lamblia cysts and Cryptosporidium parvum oocysts. The treatment efficiency of each UV treatment unit depends on the light intensity and saturation level of the specific device installed as well as the clarity of the water being treated.

UV treatment is not recommended if the untreated water has a coliform content exceeding 1,000 total coliforms or 100 fecal coliforms per 100 mL.

It is important to note that although UV light is an effective disinfectant, disinfection only occurs inside the unit. No disinfection occurs beyond the treatment unit to kill bacteria that survived or were introduced after UV treatment. If residual disinfection is necessary, chlorination may be necessary in addition to or as an alternative to UV treatment.

Assessment criteria for UV treatment

Regardless of the quality of the equipment purchased, it will not perform satisfactorily unless maintained in accordance with the manufacturer's recommendations for maintenance, cleaning and part replacement. Keep a logbook to record water test results, equipment maintenance and repairs.

Because UV radiation has to reach the microorganisms being treated in order to be effective, the housing for the light source should be kept clean. Commercial products are available for rinsing the unit to remove any film on the light source. An overnight cleaning with a solution of 0.15 percent sodium hydrosulfite or citric acid effectively removes such films. Some units have wipers to aid the cleaning process. Filtration and/or ion exchange are also recommended prior to most UV systems to improve the transmissivity of light though the water passing through the UV system.

UV systems are designed for continuous operation and should be shut down only if treatment is not needed for several days. The UV lamp needs a few minutes to warm up before the system is used again following shutdown. In addition, the water system should be thoroughly flushed following a period of no use. Whenever the system is serviced, the entire water system should be disinfected prior to relying on the UV system for disinfection.

UV lights do not burn out but gradually lose effectiveness with use. The lamp should be cleaned on a regular basis and replaced at least once a year. It is common for a new lamp to lose 20 percent of its intensity within the first 100 hours of operation, although that level is maintained for the next several thousand hours.

Units equipped with calibrated UV emission detectors alert the owner when the unit needs cleaning, or the light source is failing. This is an important feature to ensure a safe water supply. A detector that emits a sound or shuts off the water flow is preferable to one with a warning light. Detectors should not supplant annual replacement of the light source or regular cleaning of the lamp housing. When approved for bacteriological treatment, two or more UV devices are required to be installed in parallel so that redundancy is provided if one UV light fails or other technical problems occur.

The treated water should be tested for coliform bacteria on a monthly basis for at least the first six months of the device's use. If bacteria are present in the treated water, the lamp intensity should be checked and the entire water system should be shock chlorinated.

5. Other Treatment Methods

Many NN systems have at least one form of treatment. Treatment devices may be installed in series within the same water system as part of a treatment chain to treat one or multiple contaminants. Treatment processes can control inorganic or organic contaminants. Some address primary regulated contaminants, while others target aesthetic issues. Below is a list of various treatment processes observed during sanitary surveys that may have been issued a treatment approval. Photographic and written documentation of treatment processes can include type of treatment device, manufacturer and model number of device, what the device is treating, what media is used (if applicable) and where the treatment is installed within the water system. These are common treatment processes; however, others may be observed in the field and should be properly documented and shared with other staff.

A. Physical removal

- Ion exchange devices (i.e. water softeners, etc.) – Can be anion or cation
- Arsenic filters
    - Modified iron filter (usually, but not always, a Hellenbrand product)
    - Dissolved oxygen generator (i.e. Water D.O.G.)
- Iron filters (adsorption and precipitate system)
- Particulate, sediment or cartridge filters (physical)
- Reverse osmosis
- Distillation (especially heavy metals)

B. Chemical reaction

- pH adjustment
- Granulated active carbon (GAC) filter
- Aeration tanks or towers
    - Air stripping towers for VOC removal
- Ozonation (O_3)
- Chlorine (enhanced iron precipitation for arsenic removal)
- Modified filtration by media type
    - Ultra
    - Greensand
    - BIRM
    - Hybrid anion exchange resin
    - Coconut shell (Vitasalus – NSF approved)
    - More
- Ceramic micro filter in candle or cartridge form (removal of bacteria and parasites – virus removal with added chlorine) used in some U.S. states

C. Sequestration / Inhibition - Primarily used in corrosion control of lead and copper

- Phosphates (ortho, poly, ortho/poly blend)
- Potassium permanganate
- Hydrous manganese oxide (HMO)

6. Typical Treatment System Issues

Proper application: Treatment devices require DNR approval for the application and site-

specific installation approval from DSPS. The approval process confirms the proper device is used for the correct application to achieve the most effective desired reports. Verify treatment systems meet the manufacturer's specifications and designed use. Confirm with the water system operator that treatment continues to be installed and operated as required in any approval letters and according to the manufacturer's specifications.

Equipment calibration: Ensuring proper water treatment requires that the equipment used to evaluate treatment system efficiency be in proper working order. This includes equipment such as scales, flow meters, chemical feed pumps, turbidity meters, pH meters, chlorine meters and temperature gauges/thermometers. If this equipment is not calibrated regularly, adequate water treatment cannot be guaranteed. A good practice is to calibrate chemical feed equipment whenever a new batch of chemicals used. Frequent verification of chemical feed pump rates should be part of regular operator duties.

Adequate instrumentation and controls: There should be enough instrumentation to provide all the information an operator needs to determine the proper dose is being delivered and that the treatment system is functioning properly. These include flow meters and analytical tools such as residual chlorine sample results. In addition, these instruments should be properly calibrated and in working order. The operator should be able to explain calibration procedures for each instrument and be able to explain how the results of the measurements or water quality samples are used.

Proper storage: Water treatment chemicals should be stored in a clean, dry location away from other incompatible chemicals such as petroleum products. Proper spill containment is recommended to be included around liquid storage facilities. A supply of 30 days of chemical is recommended to be on hand. To reduce disposal of unused liquid chlorine that is no longer effective due to degradation of the active ingredient, it may be appropriate for NN systems with emergency chlorination to only have means to obtain chlorine and achieve a 0.5 mg/L chlorine residual concentration at the end of the distribution system within 4 hours rather than keeping a supply on site at all times. Unused liquid chlorine must be disposed of properly. According to NR 810.19, discharge directly to a surface water is prohibited unless specific approval is obtained prior to the discharge. Staff should recommend the system representative contact DNR wastewater program staff prior to discharging chlorinated water to surface water to ensure compliance with Wis. Stat. § 283.31(1).

2.2.7(e) Distribution

Definition: Reviews the design, operation, maintenance and management of distribution systems to prevent contamination of drinking water as it is delivered from the source to consumers.

Objectives:

- Review the major components of a water distribution system, including pipes, valves, meters, meter vaults, fire hydrants and interconnections.

- Identify operation and maintenance tasks necessary to maintain the integrity of the water distribution system, such as flushing and locating dead-ends within a distribution system.

- Call attention to factors that contribute to reduction in water quality in a distribution system such as cross connections and potentially harmful materials.

Applicable Wisconsin Administrative Codes for NN water system distribution systems:

- NR 809, Subchapter II – lead and copper rule compliance
- NR 810.15 – cross connections and interconnections
- NR 812.35 – yard hydrants
- NR 812.41 – flushing
- SPS 382.41 – cross connection control (backflow/backsiphonage protection)
- SPS 382, Appendix – yard hydrants and cross connection control
- SPS 381, 382 and 384 – plumbing requirements

1. Distribution System Plumbing and Management

A. Material requirements and documentation

Potable water system plumbing requirements are covered by the Wisconsin plumbing code (SPS 381, 382 and 384). The Department of Safety and Professional Services (DSPS) is responsible for its implementation. While DNR staff completing sanitary surveys are not expected to understand all aspects of the plumbing code or to enforce its requirements, it is helpful for DNR field staff to be familiar with its basic requirements and be aware of overlapping areas, such as approved plumbing products, cross connection control (backflow/backsiphonage protection), leaks, etc. that are addressed during the sanitary survey process. Additionally, although water supply specialists completing sanitary surveys are not required to thoroughly inspect each public water distribution system, parts of the premise plumbing will be encountered during the sanitary survey and system components or monitoring sites are visited. If obvious problems are noted, they should be described in the sanitary survey documentation and properly corrected. Water supply specialists should consult with DSPS staff regarding any questions regarding cross-connection control and about any unresolved cross-connection concerns.

When reviewing water system records before a sanitary survey, DNR staff should try to find a copy of a blueprint, floor plan, as-built drawing or schematic of the water system and review it to get an understanding of how the system is configured and any possible problem areas. If there is not a blueprint, floor plan, as-built drawing, or schematic of the water system in the file, inquire during the sanitary survey if this information is available.

B. Distribution maintenance

Fixing leaks in a public water system should be identified as a recommendation due to the potential to lead to contamination of the public water system unless there is a corresponding code requirement to cite. If a system is experiencing unexplained water loss, water contractors, licensed plumbers or the DNR's technical assistance contractor (currently WRWA) may be able to assist with leak detection or provide tools to help detect leaks.

Although not required by code, consider discussing the advantages of:

- Pipe replacement programs to eliminate leaks before they start
- Routine flushing to remove sediment and improve water quality within storage vessels and plumbing (for systems with flushing hydrants installed within the distribution system)
- Valve exercising to keep valves from sticking in an open or closed position and avoiding expensive work or production stoppage that may be required to fix the problem
- Eliminating dead-end plumbing by removing unused water lines or looping the distribution system plumbing to reduce stagnant water zones and the potential for increased bacteria risk
- Keeping the distribution system positively pressurized (if water pressure inside a section of piping below the water table reaches zero or negative pressure, contaminated water from the soil or even from the piping surface could enter the piping through cracks within a pipe section or at pipe joints)

2. Cross Connections

Unprotected cross connections in a public water system are prohibited by NR 810.15 and must be protected per SPS 382.41. Non-transient non-community water systems are encouraged to have their own cross connection control program. Actual or potential cross connections may be encountered during a sanitary survey. Although water supply specialists are not responsible for administering plumbing code requirements, the following items should be considered. SPS 382.41 indicates any termination that a hose could be connected to is considered a high degree of hazard. As a result, it requires proper backsiphonage protection be installed. There are three exceptions to this requirement provided in SPS 382.41(3)(b)5.: 1) if the outlet is only for draining the system down, 2) if the outlet is only for obtaining water samples, or 3) if the outlet is only for the purpose of an automatic residential clothes washing machine hook up. Per SPS 382.41, discharge/drain lines from treatment devices (e.g., water softener) must end at least two pipe diameters (no less than 1 inch of separation) above the rims of sinks/floor drains or have a vacuum breaker tee meeting SPS 382.41(5)(j). Wasting tees are needed for chemical dispensers with ASSE 1055 markings that are not hard plumbed to the water system as noted in "*A Partial Table for the Selection of Backflow Protection"* in SPS 382, Appendix. Cross connection control assemblies are required to be tested annually according to SPS 382.22(8). Except for cross connection control assemblies used to prevent nonpotable water from a fire protection system from entering a potable water system, cross connection control assemblies need to be registered with DSPS according to SPS 382.22(8). Each of these assemblies is required to have a tag showing the regulated object ID number and the last testing date. Cross connection control assemblies requiring registration and testing are displayed in Table SPS 382.22-1. Water system owners typically contract with licensed plumbers to install and register testable assemblies, whereas only registered cross connection control testers may conduct

performance tests of cross connection control assemblies.
Existing yard hydrants with weep holes that allow water to bleed back underground to prevent freezing are considered non-conforming features because contamination can enter the distribution system through the weep holes. Newly installed yard hydrants that have weep holes are noncomplying. Yard hydrants that do not have weep holes but instead have small below ground reservoirs to collect the drained water are conforming (SPS 382, Appendix references compliant hydrants). Per NR 812.35, yard hydrants cannot be installed on wells and those with threaded hose outlets shall be fitted with a hose connection atmospheric vacuum breaker (ASSE 1011 or 1052). Alternatively, a reduced pressure principle backflow preventer (ASSE 1013) may be installed on the water line serving one or more sanitary yard hydrants in a high hazard application. Hose thread outlets are considered high hazard. DNR and DSPS have publications for yard hydrants that can be viewed at https://dnr.wi.gov/files/PDF/pubs/DG/DG0084.pdf and https://dsps.wi.gov/Documents/Programs/Plumbing/ProtectYourWaterYardHydrantsInWisconsin.pdf [Exit DNR], respectively.

If water from the drinking water system also serves nonpotable uses, appropriate cross connection control must be provided, such as an air gap or reduced pressure principle backflow prevention assembly (i.e. ASSE 1013), as required in SPS 382.41 and referenced in Table 382.41-1 titled "*Acceptable Cross Connection Control Methods, Devices or Assemblies*" (also in SPS 382, Appendix "*A PARTIAL TABLE FOR THE SELECTION OF BACKFLOW PROTECTION*" on page 177 in the version effective December 2018). Specific cross-connection control requirements for fire suppression systems based on the date of installation are provided in SPS 382.41 and the SPS 382 companion appendix. Surveyors may encounter facilities that take water from the drinking water system to fill tanks with water which is then piped off for nonpotable uses. The nonpotable and potable water are typically isolated from each other by an air gap (at least 2 pipe diameters of separation, but not less than 1 inch) or a reduced pressure principle backflow prevention assembly (ASSE 1013). Water properly separated from the drinking water system would be considered nonpotable and can be fed out to different areas of a building though a piping system separate from the potable water system. If properly separated from a public water system, the nonpotable water system would not be subject to public water system rules (including cross connection control requirements). However, DSPS may enforce the water system labeling requirements provided in SPS 382.40(3)(d).

When air gaps, vacuum breakers or other backflow/backsiphonage devices/assemblies required by SPS 382.41 are missing or have failed, they will need to be addressed/corrected/replaced in order to comply with the corresponding code section. Failed or untested cross connection control between substantial interconnections or potable and nonpotable water present a significant risk. When an air-gap between a softener discharge and a receiving drain is less than two pipe diameters this presents a moderate risk of cross contamination. If a threaded hose bibb is missing its vacuum breaker, this might be considered a mild risk but a high hazard potential cross connection. Hose bibb users often remove the vacuum breakers, either for easy access or because they don't know they are required or what purpose they serve. Missing vacuum breakers need to be replaced unless the fixture meets one of the exceptions provided in SPS 382.41(3)(b)5. Surveyors may also want to recommend water system staff periodically go through the water system and replace all required hose bibb vacuum breakers that are missing. Over time, more and more new construction is using outside hose bibbs with built-in vacuum breakers. These fixtures are preferable because there is no vacuum breaker that can be removed from the end of the fixture.

One additional scenario to mention is systems that use drinking water to fill ponds, fountains or other water features, including baptismal fonts. These are typically operated by a float that triggers the addition of water when the water level reaches a set point. Many of these have adequate cross connection protection, while some do not. The surveyor should ask how they are maintained, where the receiving drain is located and check if appropriate cross connection control is provided.

Although sanitary survey staff are not expected to look closely at internal cross connection control measures inside machinery or appliances such as dishwashers, beverage dispensers, clarifiers, washing machines, etc., cross connection problems with these devices have been known to occur. These are often hidden in the machines or are part of a complex piping/valving arrangement. Therefore, these types of cross connections might only be corrected if identified as a concern during a cross connection control survey or after a problem is present and a level 2 assessment type investigation has determined it to be the source. These more complex systems/devices should be frequently and properly maintained by professionals. It is appropriate to recommend a cross connection control survey be completed by a qualified plumbing contractor in the sanitary survey documentation.

3. Interconnections

Per NR 810.15(2), interconnections between a public water system and another source are prohibited unless permitted by the DNR in individual cases. When approved, these will have robust backflow prevention. If a public water system has one of these interconnections, surveyors can read the interconnection approval to determine if the water system is complying. A copy of the interconnection approval should be added to or kept in the DNR file for this NN system.

4. Lead in Water System Plumbing

A. Historical context and legislation

Historically, lead and lead alloys (brass, bronze, etc.) have been used extensively in drinking water systems. Many of these products are still in use, particularly in older water systems in which the plumbing has not been replaced.

Due to increasing recognition of the hazards of lead, restrictions on lead in solder and plumbing was restricted in 1984 in Wisconsin and in the 1986 Safe Drinking Water Act (SDWA) amendments. This law required only lead-free products be used in potable water systems. Per the SDWA, “lead-free” was defined as having less than 8.0 percent lead in piping, fixtures and fittings used on potable water systems and less than 0.2 percent lead in solders and fluxes used on potable water systems.

The Reduction of Lead in Drinking Water Act was signed in 2011 and passed in 2014. This law further reduced the lead content of certified lead-free components of potable water systems to 0.25 percent lead in the wetted surface material for pipes, fittings and fixtures (exceptions for certain valves and fittings, including hose bibbs) but remained at the 0.2 percent level for solder and fluxes. These requirements appear in SPS 384.30(4) and 384.40(4)(c), respectively. Higher lead content components can be sold in stores but should be labelled for nonpotable use.

B. Resolutions for compliance

Based on these laws, most newer discharge lines as well as potable plumbing and fixtures should be certified as lead-free (< 8 percent lead content in 1986 or < 0.25 percent lead content in 2014). Plumbing components installed before 1986 (particularly lead, brass or bronze components) are likely to have higher lead content than more recently installed plumbing components or soldered joints.

Expensive fixtures such drinking fountains are often used for long periods of time and may be in use several decades after installation. Drinking fountains that chill the water typically contain manifolded refrigeration units with additional soldered joints resulting in units with expanded area of water/metal contact. If these drinking fountains are old, they are likely a prime lead sampling location, particularly when in schools. Recognizing the role age plays in the lead content of piping and fittings as well as the increased water/metal contact in certain designated drinking locations, may be helpful when selecting appropriate lead monitoring sites.

2.2.7(f) Operation and Management (O and M)

Definition: Evaluates water system performance in terms of management and operation, including its long-term viability in meeting water quality goals.

Objectives:

- Identify the effectiveness of a water system's management.
- Ensure continued, reliable operation through adequate staffing, regulatory compliance, provision supply and equipment repair and replacement.
- Consider the technical capacity (personnel, equipment and training) for the system to provide safe water for consumption.
- Evaluate the system's previous and future financial capacity to operate the public water system and determine its long-term financial viability.
- Review and evaluate the plan(s) for safety, emergency situations, maintenance and security to ensure system reliability.

Applicable Wisconsin Administrative Codes for NN system operation and management practices:

- NR 809
  - Subchapter I – proper sampling and monitoring, MCL responses
  - Subchapter II – lead and copper action level exceedance responses
  - Subchapter VI – conditional waivers and variances
  - Subchapter VII – management of public notices
- NR 810

- 810.03 – general operation requirements
- 810.04 – certified operator requirements (NR 114.30-32, cross-referenced)
- 810.13 – system maintenance requirements
- 810.15 – cross connections and interconnections
- 810.23 - 810.26 – water system security, capacity, operations and plans

- NR 812.26 – filling and sealing wells

1. Capacity Development

A. Required forms and review

According to NR 810.24, owners of newly-constructed, newly-discovered, newly-upgraded (in system type), or newly-operational (after a *substantial* period without operation) NN systems are required to complete and submit a completed *Capacity Evaluation for Non-Transient Non-Community Public Water Systems* (Form 3300-246) to the DNR. The DNR capacity development coordinator will review the submitted form and approve or deny the system's technical, managerial and financial capacity to operate the system before the facility can begin serving water.

1. Administrative code *does not* specify what qualifies as a *substantial* period without operation. Rather, if a system has been inactive for a certain amount of time, DNR field staff should communicate with the capacity development coordinator to determine whether the period of inactivity and the surrounding circumstances are significant enough to warrant capacity evaluation form submittal (typically, a period of inactivity of 6 months or longer would prompt this, though there may be other system changes that have taken place to consider).

2. For the newly-discovered system that is already operating, it is obviously not possible for this system to submit a completed capacity evaluation form prior to serving water to the public. Submitting a completed form should be made high priority for such systems. Contact the DNR capacity development coordinator for any identified NN system that commenced operation after September 1, 1999 that has not yet demontrated appropriate technical, managerial and financial capacity.

During each subsequent sanitary survey (whether it is the normal five-year inspection, part of a transition from TN to NN or in response to a new well or system expansion), the surveyor will evaluate whether the facility is continuing to maintain the system's technical, managerial and financial capacity to a degree that will allow the system to continue to reliably supply safe water to its consumers. There are only two responses survey staff can give - either the system *has* adequate capacity, or it *does not*. There is space to explain why the facility has or has not shown adequate capacity in the sanitary survey report or sanitary survey report and notice of noncompliance.

A *Capacity Evaluation for Non-Transient Non-Community Public Water Systems* is not required to be completed during a normal five sanitary survey capacity development evaluation, provided the DNR already has an approved form on file for the public water system, or the water system precedes the September 1, 1999 code stipulation. However, if it is an initial sanitary survey for a startup system, a TN transitioning to an NN, or a water system that does not precede the September 1, 1999 code stipulation, survey staff will obtain a copy of the *Capacity Evaluation for Non-Transient Non-*

Community Public Water Systems as well as all other capacity guidance resources from the capacity development coordinator to provide to the system owners/operators. The capacity development coordinator and water supply specialist assigned to the system may both serve as resources to the public water system throughout its operation, as the capacity development process is an ongoing one.

B. Evaluation process

While having the correct credentials to operate a NN water system is a part of the evaluation, the capacity development determination made during the sanitary survey is not based on just licenses, credentials and sources of funding. Instead, the sanitary survey capacity development determination is a broad evaluation of the facility's continuing technical, managerial and financial capacity to operate the public water system in a compliant manner, stay aware of current regulatory requirements, maintain readiness to address unforeseen circumstances (component replacement, MCL exceedances) and consistently provide safe water for its consumers.

If it is determined the system does not have adequate capacity, be sure to discuss what would be necessary for the system to demonstrate it possesses adequate capacity.

Sanitary survey staff make the capacity determination based on criteria such as:

- *Do owners/operators correct deficiencies within the deadlines established through the sanitary survey process?*
  Any missed deficiency deadline may be evidence the owner or operator is not taking the issue seriously and therefore may be demonstrating that they do not have adequate managerial capacity. If deficiencies have not been corrected by the previously specified due date (or any extended due date), and they are still unresolved during the next sanitary survey, a significant deficiency would be identified on the next sanitary survey report with notice of noncompliance language. If significant deficiencies have not been corrected by the originally specified due date (or any extension), the unresolved significant deficiencies become Treatment Technique Violations (TTVs). Failure to notify is a separate violation. Systems with TTVs for failing to correct significant deficiencies are to be referred for secondary enforcement. As a TTV, the system would have 150 days to have an enforcement action (typically a consent order) in place or to have the significant deficiency remedied.

- *Have owners/operators established short-term and long-term plans for the facility?*
  Ask the owner/operator if there are system or treatment system upgrades/changes planned and if the facility is moving, expanding, shrinking or remaining unchanged for the foreseeable future. A thorough answer will demonstrate that they have given this thought and are actively planning (e.g., the owner plans on adding a third building and will be submitting approval requests for a second well and treatment system by next year).

- *Are there ongoing unresolved enforcement issues, or have all enforcement issues been resolved in a responsive and prompt way?*
  If enforcement deadlines have been consistently missed without good cause, then

the system has probably failed to demonstrate adequate capacity for at least one capacity category as long as the enforcement deadlines were practical. Sometimes enforcement deadlines are missed through no fault of the facility (e.g. the plan review and approval process may be delayed, or unforeseen circumstances may have been encountered). In these cases, make sure to account for all factors involved before making a determination.

- *Are treatment systems operated and maintained correctly and do the operators have the proper credentials?*
  If post-treatment samples show inconsistent concentrations of contaminants, the system may need help adjusting the treatment system to achieve stability and to maximize efficiency. Unless the surveyor has specific knowledge on how best to operate a particular system, it is best to refer system operation questions and adjustments to qualified water system professionals (contracted engineers or water treatment companies, though DNR or DSPS engineers may also be available to provide general guidance). Any operator of an NN system is required to hold the DNR's Small System Operator certification; however, NN systems with more complex treatment systems may benefit from having an operator who has more advanced and specific certification subclasses. Note that an operator who holds a Municipal Waterworks Operator certification is qualified to operate a NN system and does not need to obtain the Small Water System Operator certification.

- *Are adequate records of water system operation and maintenance being kept?*
  According to NR 809.82, records should be maintained for the specified period for analytical reports, violation correction records, sanitary survey records, conditional waiver or variance records, lead and copper control records, public notice records, monitoring plan records, assessment forms and repeat sample extensions. In addition, field staff may recommend maintaining all other regulatory correspondence, maps, approvals, treatment system manuals and any other important water system documents. Information for the well pump, motor and drop pipe should also be maintained, especially for systems where the pump installer did not display the corresponding information near the control box, pressure switch or pressure tank. These records are typically kept in a binder or series of binders or electronic files. During a sanitary survey, corresponding records may be reviewed. The entire historical record does not need be looked over to make sure system representatives have every document that is required, but it may be good to quickly page through the file to make sure the bulk of the historical information is maintained. If water system representatives cannot produce the records, discuss the lack of documentation with the facility representative. This might be considered a deficiency and possibly provide justification for determining a lack of adequate capacity.

- *Do operators understand how to operate the system, collect samples and post public notices?*
  Survey staff will encounter sites that, even after multiple explanations, consistently collect samples using the wrong techniques or wrong sample sites, or habitually fail to post or return required public notices. Field staff need to discuss these concerns with owners/operators during sanitary surveys and set a timeframe in which improvements are to be demonstrated. If improvements are not demonstrated, these issues may be best handled through the enforcement process (NON, NOV,

enforcement conference, consent order/compliance agreement) and may also merit a determination of failed or lack of technical capacity.

- *Does the system have adequate financial capacity? Can the owner afford to replace expensive components or address MCL exceedances as needed, or have they delayed responses to these issues or indicated they cannot afford to make the necessary changes? Does the water system owner have adequate emergency funds in savings? Is there a history of promptly replacing components that are aging or is the system neglected and parts only replaced after they fail?*
  An examination of the system's bank statements is not appropriate. However, it is important that owners understand the regular costs of operating a NN water system and potential costs that can arise suddenly. To demonstrate adequate financial capacity, an owner would provide the system has the capital to cover routine water system operations and funds available to cover emergencies, equipment failures, aging infrastructure, and needed system improvements and maintenance. To this end, the owner should demonstrate adequate savings to meet unexpected costs as they arise. Field staff should note the age of certain major system components like the well, pump and storage vessels as well as any contaminant trends that appear to be approaching a MCL violation. If components are aging, corroding or decaying, or if a MCL exceedance seems imminent, the owner should plan for this expense and consider compliance options. Water system owners should be encouraged to maintain an asset inventory, tracking the anticipated remaining life of major system components. This will help owners make sound financial planning decisions. Deficiencies with financial capacity at a NN system can present in many forms: unpaid operator fees, inability to afford sample analysis or treatment chemicals, lack of emergency savings, regular equipment failure (due to insufficient replacement funds) or lack of a budget, among others. Ultimately, if a surveyor deems financial woes are responsible for a water system's inability to provide safe drinking water, financial capacity should be found inadequate.

2. Operation and Management Tasks

A. Inspection and maintenance

Under NR 810.13(1), there are several tasks that are required; including well pump maintenance, well seal inspection, vessel inspection, emergency power exercising, hydropneumatic (pressure) tank flushing and hatched hydropneumatic tank inspection. Surveyors may want to cautiously consider requiring sealed encased submersible well pumps be pulled for maintenance as there is not much maintenance that can be done for these pumps and it is expensive to pull them (replacement costs may be similar to maintenance costs).

A small percentage of NN systems have water storage facilities. Inspection and maintenance requirements for water storage facilities are provided in NR 810.14. It is worth noting this code citation provides that water storage facilities are required to be inspected at least once every five years and inspections of storage facilities 10,000 gallons or greater shall be by a professional tank inspection firm or by a registered professional engineer.

B. Management and planning

Most of the items below are not codified requirements for non-community systems, however, these are operation and management issues that could be discussed with owners/operators on how to increase efficiencies as well as maintain and operate the system to maximize its life and protect their investment.

- Handling of duties: *How are tasks divided up? Is the staffing level adequate?*

- Emergency operation plan: Facilities should consider developing an emergency operation plan that addresses multiple common contingencies.
  - *How are users notified of water system emergencies?*
  - *What if a pump or motor fails; does this affect production or just drinking water? Is there an emergency well on site? Is there a replacement pump on hand? If so, is the pump used routinely to ensure it would be functional when needed? How long before a replacement pump and/or motor can be installed? What pump installer will do the work? Would a tanker be called in to provide an alternate source of water until the pump is replaced? Do employees leave work until issue is resolved?*
  - *Does the system have backup power? If so, how is it activated and what steps are taken to make sure it has enough fuel to operate? If not, how long can the system reliably continue to provide water when it loses power?*
  - *If E. coli is confirmed, how will consumers be notified? Will water for consumption be boiled or will bottled water be provided? Can the facility served by the water system continue to operate with E. coli positive water?*
    Some food production facilities may temporarily halt production. If the system has disinfection, ensure the system representative understands only systems with disinfection that has been approved for treating water with *E. coli* would be allowed to continue serving water for consumption.

- Stuck or failed valves can stop production. They can be expensive and time consuming to fix. Although not required, most larger plants probably already have a plan to exercise all valves once or twice a year (sanitary survey staff might observe valves with tags attached listing the date the valve was last exercised). If they don't, the system representative may appreciate a reminder of this easily overlooked operational item. If feasible, the system representative may also appreciate a reminder about flushing water through the distribution system. This practice can purge stagnant water and accumulated material from within distribution system piping.

- Water conservation plan: Unless the system is pumping/wasting large amounts of water, is experiencing water availability problems, or is pumping sand due to depressed water level or depleted aquifer, this will not be big concern for owners who do not have to pay a water bill. Once there is a problem, the owner and/or operator may wish they had done things differently. For example:
  - Fix leaking pipes, valves or fixtures;
  - Adjust automatic taps so water does not flow from the tap when it is not needed;
  - Find and eliminate sources of production waste;
  - Monitor and adjust the frequency of treatment system regeneration and the

volume of water used to maximize efficiency; and
    - Use process equipment that minimizes or eliminates water usage.

- System security: Encourage owners to enhance water system security measures to prevent unauthorized entrance or protect systems from accidents. For example:
    - Lock up well, storage and treatment components;
    - Add fencing, lights or parking posts around vulnerable wells to prevent accidents;
    - Add additional signage indicating dangers and limiting access; and
    - Periodically check the wellhead and other water system components to see if vandalism or other damage has occurred.

- Complaints and follow-up: During sanitary survey inspections, the inspector should ask the operator if there have been water system complaints, and if so, what people have complained about. Because public health related groundwater contaminants are already addressed through statutes and codes enforced by the drinking water & groundwater program, most complaints heard from NN water system consumers typically regard pressure or exceedances of the secondary standards in NR 809.70, Table AA (aesthetic contaminants such as color, odor, manganese, iron, and sulphur). Surveyors may find owners who are often drinking the same water understand the problems and are often willing to address these aesthetic issues with treatment to improve the water quality and working conditions.

- Operator support training: Operators obtain continuing education credits prior to renewing their credentials. Operators who are employees of the facilities they operate should be encouraged to take additional classes when classes are offered that cover appropriate materials. Many owners will pay the usually small fee for operators to attend these classes/seminars. Inspectors may want to remind owners and operators of educational opportunities. If a system sampler is not a certified operator, recommend they become certified, or at least attend related training classes.

- Filling and sealing unused wells: Unused wells need to be filled and sealed, or returned to service (if applicable), as they present a conduit for contamination to reach an aquifer. Under NR 812.26(2)(a)4., wells which have been removed from service shall be filled and sealed within 90 days by a licensed well driller, pump installer or their firms. The well driller or pump installer will often fill and seal an existing well once a replacement well is operational. However, ask operators if there are any unfilled wells on site. If DNR staff are aware of previous wells on site for which a filling and sealing report cannot be located, survey staff will either; 1) request copies of the filling and sealing documentation (*Well / Drillhole / Borehole Filling & Sealing Report*; Form 3300-005) or 2) require the well be filled and sealed as required by NR 812.26(2)(a)4. Missing documentation or any unused wells that have not been filled and sealed would both likely be deficiencies.

2.2.7(g) Monitoring and Reporting (M and R)

Definition: Monitoring and reporting determines water system compliance with regulatory requirements through the review of a NN system's water quality monitoring history and system records.

Objectives:

- Review the water quality monitoring history of the NN system for conformance with regulatory requirements.
- Consider whether any changes in monitoring frequency or location should be recommended for any contaminant or performance measure.
- Evaluate the procedures a sampler/operator follows and reports that are filed to identify any problems with the monitoring and reporting process.

Applicable Wisconsin Administrative Codes for NN water system monitoring and reporting requirements:

- NR 809 – water quality monitoring, maximum contaminant level (MCL) compliance, public notices, lead and copper action level exceedances, lead and copper public education, lead and copper consumer notices, reporting, record retention and enforcement
- NR 810.07 – operational monitoring and reporting requirements

1. Resources for Monitoring and Reporting

A review of monitoring and reporting records is a key component of the sanitary survey. Chapter 3 Water System Operational Oversight of the operations handbook provides details about monitoring site plans, reporting and record retention.

Specific information on regulated drinking water contaminants and monitoring frequencies, including actions to take after a contaminant exceedance, can be found in Chapter 6 Water Quality Monitoring of the operation handbook. Direct questions about water quality monitoring to the public water system monitoring coordinator. Additional guidance for sample collection procedures is provided in EPA's *Quick Guide To Drinking Water Sample Collection [Exit DNR]*. It is important to note that radium concentrations are not regulated at NN systems. General reporting and record retention requirements for a NN system can also be found in NR 809.32 and 809.329. Prior to the sanitary survey, staff should review and be familiar with the system's monitoring results along with any deficiencies, nonconforming features, past recoomnedations, violations and corrective actions.

2. System Management of Monitoring and Reporting Requirements

When reviewing or inspecting the facility, review the following:

A. Maximum contaminant level exceedances and public notices

- Any violations of MCLs, treatment techniques, monitoring or reporting that are ongoing, and if appropriate, those that occurred since the last sanitary survey and have been resolved.
- *Are public notices displayed for any ongoing maximum contaminant level violations?*

Are copies of public notices required since the last sanitary survey on file?

- *Does public education continue to be provided in response to any current lead or copper action level exceedances?*

- *If the system notified its consumers of lead and copper results by posting, rather than distributing, is a Consumer Notice of Lead and Copper Results in Drinking Water or acceptable alternate documentation still posted in appropriate locations?*

B. Monitoring results and monitoring site plans

- Confirm the current non-transient and transient population served by the water system. Changes to these population numbers may affect required monitoring. Required monitoring frequencies and the number of required samples are provided in the corresponding sections of NR 809.

- Discuss monitoring results for each entry point and/or well in addition to each distribution system location. If water quality has changed over time, note the trends and alert the system representative about this situation. For example, if lead and copper results have steadily increased over the years and are approaching the lead or copper action level, it would be good to make the owner or operator aware of that fact.

- Review monitoring sites to ensure sampling and monitoring locations are appropriate (Note: detailed information on monitoring site plan requirements including requirements for bacteria and lead and copper can be found in Chapter 3. General expectations for monitoring can be found in Chapter 6.10 Monitoring Locations for Compliance Samples of the operation handbook or from the monitor coordinator). Monitoring information specific to lead and copper can be found in the DNR's *Non-Transient, Non-Community Lead and Copper Rule System Sampling and Compliance Guide*. Route questions about lead and copper sampling and compliance to the public water lead and copper rule coordinator.

- Verify the system is maintaining sample results and that samples were collected according to the approved *Non-Transient Non-Community Water Monitoring Site Plan*. Water systems are required to maintain records of bacteriological and chemical sampling results for the corresponding length of time provided in NR 809.82.

- Determine if any changes to the *Non-Transient Non-Community Water Monitoring Site Plan* or sampling frequency may be necessary, working with the public water system monitoring coordinator. Sampling requirements may change if there is a reported change in population, treatment changes, a threshold value or MCL is exceeded, a new potential contamination source not previously noted during the monitoring waiver assessment process is identified or a new water source is added. More information can be found in Chapter 6 of the operations handbook.

- Ask questions to learn more about the operation of the water system. If applicable, written approval granting initial approval or confirming previous approval that the water system is allowed to deviate from the required lead and copper sampling

procedures is needed. For example, NR 809.547(2)(e) states that a non-transient non-community water system that meets the criteria of NR 809.546(2)(g) that does not have enough taps that can supply first-draw samples, may apply to the department in writing to substitute non-first-draw samples. This would include water systems that operate 24 hours a day, 7 days a week during the lead and copper compliance monitoring period. In this scenario, it would not be feasible for water in the plumbing system of each sampling site to remain motionless for at least six hours before lead and copper compliance samples are collected as required by NR 809.547(2)(a). The code section above adds that the department may waive the requirement for prior departmental approval of non-first-draw sample sites selected by the water supplier, either through department rule or written notification to the water supplier. Written approval is also needed according to NR 809.547(3) if the water system does not have at least as many approved lead and copper sample sites as the number of lead and copper compliance samples required to be collected during a compliance monitoring period. This can be noted in writing in the sanitary survey paperwork. Discuss each of these case-by-case situations with the public water lead and copper rule coordinator.

C. Water supply treatment and reporting

- If the system has installed treatment, review operation and maintenance records (i.e. records of when and how treatment steps are taken and chemical mixtures (e.g., feed solutions) are prepared). Ensure treatment and distribution system are being monitored (e.g., feed solutions, flows, pressures, tank water level elevations, pumps, etc.) appropriately.

- Systems using the colorimetric method for measuring disinfectant residuals should have access to a set of calibration standards and have calibration records showing that the colorimeter is regularly checked against those standards. Verify that the standards have not expired. Note that a color wheel and LaMotte Checker are not considered to be an approved methodology for disinfectant residuals (based on NR 809, Table R).

- If operational reporting is required, determine whether or not data for all required parameters is being submitted to the DNR by the tenth day of the following month. This may be done with an electronic spreadsheet, paper copy or EMOR.

D. Additional reporting and maintenance

- Non-transient non-community water systems may conduct optional monitoring for operational use. Although reporting these values is not required by the DNR, any monitoring done that could result in operational changes should be kept on file at the public water system. If optional monitoring does result in operational changes, it is important for the surveyor to understand the role of operational monitoring data and whether or not this data is required to be submitted to the DNR. During the survey, the inspector should specifically ask if optional monitoring is taking place and what purpose it serves.

- Ensure the water system has documentation of repairs and preventative

maintenance to demonstrate compliance with NR 810.13.

E. Record keeping and additional procedures

- Verify that the system is maintaining other records as required (i.e. public notices, lead or copper paperwork and enforcement documentation). These requirements are provided in NR 809.82.

- *Does the facility have sampling instructions? Are proper sample collection methods used?* Talk with system about holding times and encourage development of a plan for invalid samples (e.g., frozen, etc.).

- *Does the system have an emergency preparedness plan on file?* This is not required but it is encouraged.

- If applicable, the surveyor may also consider answering questions regarding any unregulated contaminant monitoring rule (UCMR) monitoring the system may have done recently. However, note that EPA manages the UCMR program.

2.2.7(h) Operator Compliance

Definition: Certified operator compliance ensures public water supply systems have qualified professionals that meet all applicable operator certification requirements.

Objectives:

- Ensure operator is aware of certification renewal requirements and ongoing continuing education opportunities.

- Evaluate if operator(s) can perform duties and have appropriate knowledge of the water system components and any water system treatment.

- Confirm each operator understands the compliance requirements including monitoring, recordkeeping and reporting requirements.

- Evaluate whether or not the water system is in compliance with all operator requirements.

Applicable Wisconsin Administrative Codes for NN water system certified operator requirements:

- NR 114.30 - 114.32 – licensing requirements for NN water system certified operators

- NR 809.562(3) – certified operator requirement for NN systems with disinfection

- NR 810.04 – certified operator requirement for NN systems

1. Water System Operator Requirement

Similar to community water systems, NN water systems are required by NR 810.04(3) to have a certified operator overseeing the water system. The requirement ensures the water system has at least one qualified person in charge of water system operations. More information on the operation certification program and requirements can be found in Chapter 11 - Water System and Waterworks Operator Certification of the operations handbook.

2. Documentation

Prior to the survey, review the current operator information, including operator contact information and certification status. Document personnel changes and verify certified operator contact information during the survey. If more than one certified operator is affiliated with the water system, determine which operator is to be designated as the operator-in-charge (OIC).

3. Certification Requirements

Review the operator certification requirements and ongoing continuing education opportunities. Confirm each operator is aware of their certification expiration date. Mention the DNR's operator certification training calendar webpage where operators can find courses to obtain continuing education credits. Remind the system operator of the requirement to notify the DNR of any operator changes. More information on training and operator certification can be found on the DNR's Small Water System (OTM/NN) Operator Certification webpage.

4. Operator Management

Evaluate if the operator is able perform duties and is knowledgeable about the water system components. Typical operator duties may include collecting samples, maintaining water system operation and treatment (if applicable), completing corrective actions and providing public notices, consumer notifications and public education materials. The operator should also understand the compliance requirements including monitoring, reporting and recordkeeping.

It should be noted during an inspection what duties the certified operator is fulfilling for the water system (i.e. sampling, completing forms, maintenance, chemical addition), because the level of operator involvement tends to vary from system to system (especially with contract operators). This can also help when determining who should be listed as the water system sampler in DWS.

If the NN water system only has one certified operator, encourage the water system to have a backup certified operator. This will help the water system avoid a violation for failing to have a certified operator if the current operator does not renew their certification on time or if the current operator is no longer able to fulfill the operator duties for any reason. As noted above, be sure an OIC is designated when more than one operator is affiliated with a NN system.

2.2.7(i) Review Findings

Definition: As described by EPA, reporting and follow-up actions must be planned and carried out by the water system operator/owner and regulatory staff in response to the findings of a sanitary survey, including those actions that must be taken to identify and correct any deficiencies.

Objectives:

- Develop guidelines for compiling and reporting the sanitary survey results as well as suggestions for keeping adequate documentation of the sanitary survey.

- Ensure a final written report is used to notify water system owners and operators of the results of the survey, any deficiencies, non-conforming features or recommendations for improvement and to assist in facilitating corrective action.

- Explains how to develop final documentation, track violations and compliance, and when to seek enforcement steps when compliance is not achieved.

Applicable Wisconsin Administrative Codes for reviewing findings for NN water system sanitary surveys are referenced in the previous sanitary survey sections for each of the eight elements required to be evaluated during a sanitary survey.

1. Corrective Action Planning & Completion

At the completion of a sanitary survey, follow-up actions are to be planned by the water system operator/owner and DNR staff, and be carried out in response to the findings of a sanitary survey. This includes actions taken to correct any identified (significant or non-significant) deficiencies. Perhaps more importantly, sanitary survey documentation will support enforcement action, if needed, and allow future specialists to track progress on water system upgrades and corrective actions. It also summarizes information to be used during emergencies and when technical assistance providers are on site. It is the assigned water supply specialist's responsibility to the water system and to the public to provide an accurate and detailed description of improper system operation or other system deficiencies or non-conforming features in sanitary survey documentation.

2. Debriefing

One of the first steps taken when the sanitary survey is complete is for the water supply specialist who conducted the sanitary survey to review the findings with the water system representative(s) in attendance. This is an opportunity to explain what will be in the sanitary survey documentation and what will be required of the owner.

Debriefing suggestions:

- Discuss what required action will result from the survey along with timeframes for completion.
- Advise water system representatives that a report of findings and recommendations will be prepared and provided to them.
- Explain that the report will include a list of any significant deficiencies and deficiencies, which will require system follow-up. Note that any recommendations or non-conforming features will also be mentioned.
- All important issues should be covered in the debriefing so there are no surprises in the final written report. This is also a good opportunity to come to an initial agreement on compliance due dates, if applicable.
- In severe cases, immediate or interim measures to protect public health may be

needed.
- Consider additional follow-up beyond the in-person consultation at the time of inspection, such as a short email or letter summarizing the inspection and what will be included in the sanitary survey documentation.

3. Sanitary Survey Report/Sanitary Survey Report and Notice of Noncompliance

The sanitary survey report or sanitary survey report and notice of noncompliance is an important tool for tracking compliance with the Safe Drinking Water Act and for evaluating a system's compliance strategy. Wis. Stat. § 280.11(1) gives the DNR authority to develop rules and Wis. Stat. § 280.13(1)(c) gives the DNR authority to inspect drinking water supplies. The sanitary survey documentation is written with the intention of providing an accurate and detailed description of any improper operation or other system deficiencies, recommendations or non-conforming features observed during the sanitary survey. Survey staff are expected to generate each sanitary survey report or sanitary survey report and notice of non-compliance using the assessment report/letter button bar on the sanitary survey tab of the DWS. Additional language may be added to the generated template letter.

A sanitary survey report or a sanitary survey report and notice of noncompliance should include:

- The date the survey was conducted and by which DNR representative(s).
- The names of those present during the survey representing the water system and a description of their affiliation.
- Photographs of water system items needing correction and photographs of key system components.
- When possible, relevant maps or schematics of the system.
- Relevant system information such as well construction reports and monitoring site plans.
- Sanitary survey findings and a discussion of any differences in the findings presented during the debriefing from the findings in the final report.
- A list of all significant deficiencies and deficiencies with suggested approaches for correction and deadlines for competition.
- Notice of noncompliance language for sanitary survey reports with significant deficiencies or deficiencies.
- A *Verification of Corrective Action* for each significant deficiency.
- A list of all other deficiencies, in order of priority, that should be addressed to enhance water system operations and safety. A *Verification of Corrective Action* may also be provided for deficiencies or non-conforming features.
- Language granting initial approval or confirming previous approval that the system is allowed to deviate from the required lead and copper sampling procedures. Discuss these case-by-case situations with the public water lead and copper rule coordinator.
    - The system operates 24 hours a day, 7 days a week during the lead and copper compliance period, therefore, it is not feasible for water in the system to remain unused for six or more hours before lead and copper samples are collected.
    - The system does not have at least as many approved lead and copper sample sites as the number of lead and copper samples required to be collected during a compliance period.
- The specialist's signature.

- Names and organizations of people who will be sent a copy of the sanitary survey material.

The sanitary survey report or sanitary survey report and notice of noncompliance constitutes the official notification of the evaluation results. Undocumented verbal communication is not legally defensible. Therefore, document important information, such as violations or required corrective actions. Although not required in statute or code, EPA and Drinking Water & Groundwater Program management expect a paper copy of each completed sanitary survey report or sanitary survey report and notice of noncompliance be mailed to the water system owner within 30 days of the most recent sanitary survey.

Update/add information from the sanitary survey into the DWS. Certain fields can be updated by field staff, while others can only be updated by the environmental program associates (EnPAs). Updates should include information on:

- New/missing system information – contacts, casing height, pump capacity, pressure tank model, treatment, etc.
- Significant deficiencies, deficiencies, recommendations and non-conforming features;
- Action to be taken for significant deficiencies and deficiencies;
- Citing and defining any improvement recommendations and non-conforming features; and
- Dates – inspection completion, letter sent, compliance due, compliance achieved and written verification of correction action completion received.

4. Noncompliant Features Severity Classification

A. Significant deficiencies

Significant deficiencies indicate noncompliance with one or more Wisconsin Administrative Codes and/or represent an immediate health risk to consumers. “Significant deficiency" includes, but is not limited to, defects in design, operation or maintenance of a public water system, or a failure or malfunction of the water sources, treatment, storage or distribution system of a public water system that the DNR determines to be causing the introduction of contamination into the water delivered to consumers or when the DNR determines a health risk exists to consumers of the water pursuant to NR 809.04(76).

Examples of significant deficiencies (actual severity level to be determined on a case-by-case-basis using best professional judgement and any existing sanitary survey training supplements):

- Past survey deficiency not corrected
- Well or system not constructed per approval
- Well or pressure tank in noncomplying pit/evidence of flooding, or located in a floodway
- Ongoing monitoring and reporting (M/R) violations
- Uncorrected maximum contaminant level (MCL) violations
- Late, missing or incomplete monthly pumpage and chemical addition reports
- Failure to post or distribute as well as submit a Tier 1 public notice (PN)

- An unused well on the property has not been properly filled and sealed
- Buried reservoir overflow
- Pump facilities/reservoir not secured
- Direct or active cross connections
- No certified operator
- Treatment for a regulated contaminant has not been approved
- Inadequate treatment or addition of unapproved chemicals
- Insufficient well or storage capacity – complaints of low pressure or no pressure
- Sanitary issues associated with well cap or seal, or electrical conduit
- Vermin/rodent infestation

B. Deficiencies (non-significant)

Deficiencies are problems in the drinking water system that have the potential to cause serious health risks or represent long-term health risks to consumers. These deficiencies may indicate noncompliance with one or more Wisconsin Administrative Codes.

Examples of deficiencies (actual severity level to be determined on a case-by-case-basis using best professional judgement and any existing sanitary survey training supplements):

- Noncomplying sample faucet
- Reservoir not emptied/inspected in 5 years
- No backflow prevention on threaded faucet(s)
- Poor pumphouse maintenance – unsanitary condition
- Inappropriate entry point/distribution sample site
- Technical, managerial or financial capacity not met
- Failure to post or distribute as well as submit a Tier 2 or Tier 3 public notice (PN)

C. Recommendations

Recommendations are a classification of problems in the water system that hinder a public water system from consistently providing safe drinking water to consumers.

Examples of recommendations (actual severity level to be determined on a case-by-case-basis using best professional judgement and any existing sanitary survey training supplements):

- Develop an emergency contact list
- Provide emergency disinfection capability
- Dehumidification in pumphouse
- Pumphouse maintenance
- Provide emergency or auxiliary power
- Routine hydrant flushing and exercising of valves
- Consider routine flushing/treatment in response to aesthetic water quality complaints
- Develop short-term and long-term plans for system operation/maintenance
- Set up and implement a water conservation and/or management program

- Implement a well, equipment and piping maintenance program

D. Non-conforming features

System features that met code requirements at the time of a water system's construction and comply with the minimum requirements in the 1953 code but would not be allowed by current code are called non-conforming features. These are technically not deficiencies; however, they should be noted in the sanitary survey documentation. Non-conforming features need to be corrected when the any major upgrades related to the non-conforming feature are completed. A corrective action due date is not required for non-conforming features.

Non-conforming feature examples at NNs:

- Well construction complies with all general well construction requirements but does not comply with special casing area requirements for a well located within a special casing area established after the well was constructed,
- A school well constructed in caving material in 1949 does not have a minimum of 3 inches of annual space that extends at least 60 feet below ground, or
- Grout was not used to seal the annular space of a church well constructed in 1984 that now serves both the church and a school.

5. Final Documentation

The DNR is obligated to provide the water system owner with a paper copy of all sanitary survey documentation. This facility representative may appreciate also receving an emailed electronic copy of the report in addition to the paper copy. Other water system representatives, the sampler, certified operator and manager may also be sent paper or electronic copies. DNR representatives, such as the corresponding field supervisor, should also be supplied with an electronic copy of the sanitary survey documentation. Areas of concern that may arise during a sanitary survey may include cross connections or faulty plumbing, school lead and copper corrosion or waterway pollution. In these cases, other internal DNR staff or external agencies may be interested in receiving reports, such as the Department of Safety and Professional Services (DSPS) for cross connections or plumbing issues.

Electronic records should be kept on the authoring specialist's assigned work computer and within the specified location on the internal DG Projects shared drive.

6. Tracking, Verifying Compliance and Timelines for Correcting Problems

Groundwater rule (GWR) compliance: The GWR applies to all public water systems serving groundwater. Under GWR requirements contained in NR 809, sanitary surveys must address the minimum eight elements and must be conducted every 5 years for NNs according to NR 809.35. The GWR requires systems with significant deficiencies identified during sanitary surveys, or during other state activities, correct significant deficiencies within 120 days or be in compliance with a state-approved plan and schedule for correction according to NR 809.327. Failure to correct significant deficiencies on time results in a

treatment technique violation that requires enforcement action as stated in NR 809.328.

Issuing the report: Specialists have 30 days from the date of the sanitary survey to complete and send the sanitary survey report or sanitary survey report and notice of noncompliance. This timeframe is an expectation of EPA and Drinking Water & Groundwater Program management. The sanitary survey paperwork serves as a notice of noncompliance and a state-approved corrective action plan (CAP) including a proposed schedule for returning to compliance. Field staff should consult with their supervisor before issuing any corrective action due dates for significant deficiencies that are longer than one year.

Discovered violations: When violations are observed, the water supplier should be given a reasonable length of time to make the necessary corrections. The water system should respond by the response due date provided in the sanitary survey report and notice of noncompliance, which is typically within 45 days of the report date, with all deficiencies corrected or with a corrective action plan that sets compliance achieved date commitments. Violations or deficiencies are expected to be documented in sanitary survey paperwork as well as logged in DWS. Compliance due dates, corrective action completion and enforcement actions are tracked in DWS. Corrections that are made can be verified by reinspection or, when appropriate, by use of other means such as photographs. Violation resolution timeline examples can be viewed in section 2.2.17(b) of the operations handbook.

Compliance monitoring: Monitor correction of deficiencies and update the DWS PWS Actions screen upon completion. Note that the PWS Actions tab of the DWS public water dashboard highlights deficiencies with a due date coming up in less than two weeks in yellow and highlights deficiencies with a due date that is overdue in red. Depending on the severity, field staff should contact the system at least one time within a week or two before the compliance due date to ask about the status of correcting any deficiencies. According to EPA guidance, the state regulatory agency should make regular and continued surveys of the facility until all significant deficiencies have been corrected as provided in *"Sanitary Survey Guidance Manual for Ground Water Systems, October 2008."*

- If a response to one or more significant deficiencies in a sanitary survey report and notice of noncompliance is not provided by the response due date, field staff will submit a completed secondary enforcement request form to their field supervisor for routing to the environmental enforcement program requesting a Notice of Violation (NOV) and an enforcement conference.

- If the water supplier, as defined by NR 809.04(91), fails to agree with the DNR on a CAP for any significant deficiencies within 120 days of sanitary survey completion, or if corrective action(s) are not completed by the agreed upon due date(s), a Treatment Technique Violation (TTV) is issued according to NR 809.328. When this occurs, field staff verify the current status of all required corrective actions. If they have not been completed, staff should complete a secondary enforcement request form and obtain approval from their field supervisor. The enforcement request should include a NOV; enforcement conference; and a consent order or administrative order.

- During each sanitary survey, field staff should verify the status of previously identified

deficiencies, including non-significant deficiencies (the sanitary survey checklist includes a question for recording this, under the “public water system management and operation” element of the sanitary survey). If past inspection deficiencies have not been corrected, it is appropriate to identify a “system management” significant deficiency. It may also be appropriate to identify a “system management” significant deficiency if any previously corrected deficiencies are observed in a noncompliant condition during a subsequent sanitary survey. Establish a deadline for correcting this system management significant deficiency, along with a list of all the corrective actions to be completed by that deadline. If the system fails to complete corrective action(s) by the deadline, a TTV will be issued per NR 809.328. When this occurs, field staff will complete a request for secondary enforcement (as described above).

- The sanitary survey process may also uncover non-significant deficiencies that have not been previously identified. These deficiencies may be a result of a change in water system components or in the operation and maintenance of the water system. These deficiencies will be identified in a sanitary survey report and notice of noncompliance. Field staff should work with water system representatives to correct these deficiencies. If non-significant deficiencies are not corrected, field staff should discuss with their supervisor if it would be appropriate to submit a request for secondary enforcement (as described above) to aid in the completion of corrective action.

- Refer to Chapter 12 – Enforcement of the *Public Water Supply Operations Handbook* for more information on primary and secondary enforcement processes.

2.2.7 On Site Inspection – OTM Groundwater Systems (Not Developed)

There are eight elements that must be evaluated during any sanitary survey (NR 809.35(5)). They are as follows:

2.2.8(a) Source

2.2.8(b) Pumps/Facilities Controls

2.2.8(c) Treatment (Not fully developed)

2.2.8(c)(i) NSF 60 (5/13/2013)

During the sanitary survey and any time chemical use changes, DNR REPS shall evaluate each chemical used by their assigned systems to determine if the chemical is still NSF 60 approved and if the current dosing is less than or equal to the NSF required maximum use level (as product) as shown on the NSF or WQA (alternate to NSF) websites.

NR 809.25(4),requires annual reporting to the Department by systems that use chemicals containing acrylamide and epichlorohydrin and rather than an MCL these chemicals have treatment technique requirements. As of 1/1/2013, Epichlorohydrin was not detected in any

of the testing that NSF has conducted on commercially available chemicals. In lieu of annual reporting by the system, the following shall be done:

1. For those water systems using chemicals containing acrylamides, the appropriate DNR REP shall verify, **annually**, that the water system continues to use the identified chemical and that all use is below the NSF max use. This can easily be done by using EMOR. (Formula: pounds used/(8.34 x gallons treated in millions). If the dose is less than the NSF Max Use, simply print out the NSF web page with the product on, note the feed rate the system is using, sign and date the bottom and put in the file.

2. If the system exceeds the NSF 60 Max Use Level based on the results contained in EMOR, the DNR REP must then generate a Treatment Technique Violation for the system, which requires them to public notice within 30 days (Tier 2 PN). NR 809.952 and Appendix A to Subchapter VII.

3. In addition to the Tier 2 PN, they are required under, s. NR 809.83(5)(d), to include the appropriate language from NR 809 Appendix A in their annual CCR. This will not be included in the on-line CCR the DNR generates. Example language to include in the NON/Treatment Technique violation letter:

   Treatment Technique Violation
   Our system exceeded the dose for [chemical name]. The NSF 60 Maximum Use Level for [chemical name] is [number] mg/l. Our dose was [number] mg/l on [dates]. This chemical is added during water treatment to improve the filtration process. Some people who drink water containing high levels of acrylamide over a long period of time could have problems with their nervous system or blood, and may have an increased risk of getting cancer.

Links to NSF and WQA (an alternative to NSF): http://www.nsf.org/Certified/PwsChemicals/
http://www.wqa.org/goldseal/goldsealSearch.cfm
(scroll down and select Drinking Water Treatment Chemicals)

2.2.8(d) Storage

2.2.8(e) Distribution System

2.2.8(f) Operations & Management

2.2.8(g) Monitoring & Reporting

2.2.8(h) Operator Compliance

2.2.8(i) Review Findings

2.2.9 On-Site Inspection – MC Systems (07/02/2019)

As defined in 40 CFR 141.2, a sanitary survey is an onsite review of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation and maintenance for producing and distributing safe drinking water. The main purpose of a sanitary survey is to identify any deficiencies and establish a corrective action plan.

This guidance is intended for use by DNR Water Supply Engineers conducting sanitary surveys of municipal drinking water systems. This abbreviated guidance is intended to supplement the publicly available guidance from US EPA, specifically the 291-page document, "How to Conduct a Sanitary Survey of Drinking Water Systems: A Learner's Guide," Draft Final Edition as of September 2015. Content from this US EPA guide is repeated herein only if particular emphasis is needed. This abbreviated guidance is also intended to supplement the DNR sanitary survey checklist. Content from the DNR checklist is repeated herein only if particular emphasis is needed.

2.2.9(a) Source

This section applies to groundwater and surface water sources and their facilities. In addition to confirming the information below, verify all fields of the DWS Sanitary Survey Entry Point and Sources sections are completed and if necessary, update. See sec. 2.2.3 for additional information.

Groundwater Well

- Verify construction complies with all applicable portions of NR 811.12. (review well construction report, if available). Verify well is not constructed in such a way that it is a dual aquifer well, drawing from two different aquifers separated by a confining layer.
- Verify that construction complies with all applicable portions of NR 811.14 through 811.20, depending on well geology.
- Verify the well is located outside of all required setbacks. Check the vulnerability assessment map viewer for contamination sources. (The vulnerability assessment map viewer can found on the DG intranet webpage under map viewers).
- Verify that the monitoring waiver assessment has been completed for each well. See sec. 6.9 of this handbook for details concerning monitoring waiver assessments.
- Verify status of Emergency Wells / Emergency well agreements if applicable, NR 810.22. Follow up if updates are needed. Consider documenting the date the last time the well pump was pulled and whether and when the well has been televised. Under NR 810.22(9), emergency wells older than 70 years are required to be televised once every 15 years.

Flowing Well NR 811.12(1)(h) In addition to the information above, verify the well head contains the following features:

- Controlling valve: The valve must be throttled as much as practical to prevent the erosion of the confining bed and to prevent waste of water. If the flow ceases, the control valve must be closed.
- Flow to waste pipe must be metal and welded to the protective casing 6 inches above the concrete floor.
- Flow to waste piping must extend horizontally through the pump base and include a check valve and shut-off valve on the portion of the piping located inside the building.
- Waste piping must terminate outside the building with:
    - 24-mesh non-corrodible screened pipe opening,
    - downward turned pipe elbow and
    - with a free air break over the top of a storm water sewer inlet or other department approved location.

Surface Water Intake / Shore Well

- Discuss whether intakes and shore wells comply with NR 811.22 and 811.23.
- Discuss how the intake(s) is located for inspection and who has access to this information
- Discuss maintenance activities to address zebra/quagga mussel issues and scope of the inspection frequency of the crib based on the need for mussel removal.
- Discuss age, size, capacity, recent cleaning operations
    - Determine if they have any reduction in capacity and what corrective actions they are taking.
    - Make sure they have a plan in place for routine O&M of the intake pipes and cribs.
    - Is O&M adequate based on the inspection reports or should they increase in either frequency or scope?
- Verify recent intake dive inspection information.
- Verify the operating conditions of the intakes and discuss operational issues (i.e. recent cleanings, use of one intake over another, problems with frazil ice, alarm levels that indicate problems, ability to backflow intake if needed, etc).
- Method used to eliminate debris (i.e. traveling screen)
- If they have only one intake, discuss the benefits of redundance and inquire about whether installation of a second intake is under consideration. NR 811.232 and NR 811.42(3).
- Discuss any outstanding conditions related to applicable approval letters for the intake(s).
- Observe security of the shore well (locked fence) and discuss the security measures with the operator, per NR 810.23(1).

Source Water Quality

- Discuss how raw water samples are collected and make sure the samples are collected from a tap prior to all treatment. If the tap is located after the check valve verify that the operator is running the well pump when the sample is collected to ensure the sample is representative of the source water.
- At surface water systems, discuss the process for collecting raw water samples if the system has a chemical feed for mussel control. Make sure the water system owner or operator understands that the chemical must be shut off well in advance of the sample collection. This is critical for Long Term 2 Enhanced Surface Water Treatment Rule (LT2) sample collection.
- Discuss any known bacterial compliance issues with the source. Discuss what their plan is for long term use of the source.
- Discuss any increasing trends on water quality parameters (Chloride, Sodium, Arsenic, Nitrate, etc.).

Source Water Quantity

- Review source water capacity as described below and discuss your findings with the system. If further information is needed to determine whether capacity is adequate, contact the system for further information and discussion.
- For surface water intakes, discuss any capacity issues related to frazil ice and debris in the intake.

The department considers a public water system to have adequate source capacity when

both of the following two conditions are satisfied:

1. The maximum daily demand can be met with the largest source out of service while pumping 18 hours per day or less and
2. The average daily demand can be met with the largest source out of service while pumping 12 hours per day or less.

Note, if downstream treatment for an MCL requires throttling back a well, the maximum pumpage through the treatment system is used for these calculations.

For the initial review, the department relies on data reported by the water system to the Public Service Commission (PSC). Refer to page W-14 of the Public Service Commission (PSC) Annual Report. Divide annual use by 365. To determine the maximum daily water use for the previous year, begin by referring to page W-15 of the PSC Annual Report. If the report indicates that the maximum daily water use was caused by distribution system flushing or water storage facility maintenance, then request that the water system provide the maximum daily demand for that year which was not attributed to flushing or water storage facility maintenance.

If the previous year data shows inadequate source capacity, then review the prior 5 years of PSC annual report water use data to determine whether the previous year is an anomaly. Similar to above, if the maximum daily water use for prior years was due to distribution system flushing or water storage facility maintenance, then request that the water system provide the maximum daily demand that was not attributed to flushing or water storage facility maintenance. If there is an anomaly, further discussion with the system on water system demand and source capacity may be needed in order to arrive at an appropriate source capacity determination.

If based on this analysis the water system does not have adequate source capacity, then make a recommendation in the sanitary survey report that an engineering study be performed to do an in-depth evaluation of the water system's capacity.

In alignment with NR 811.26, the department considers a groundwater system with only one source to not have adequate capacity. If a public water system has only one source of water, make a recommendation in the sanitary survey report suggesting the municipality install another water source.

Maintenance of Source - Well

- Discuss any issues identified regarding electronic monthly operating reports that show trends in pumping water levels that indicate declining capacity, which requires a well inspection and possible maintenance. Monthly electronic operating report requirements are set forth in NR 810.07.
- If there have been positive coliform samples, recommend that the system investigate the source of coliform. Raw water positive bacteria samples could represent maintenance issues. If the system does not continuously chlorinate, recommend that they do so, or depending on the investigation, recommend a new source.

Maintenance of Source – Surface Water

- Discuss water quality which could present pump issues (metals and hardness).

- Discuss surface water raw water quality and any need for pretreatment, and if any man-made water uses are causing raw water concerns. Review proposed strategies for cyanotoxin and mussel mitigation.
- Verify chemical treatment applied at intake and/or shorewell meets applicable code requirements, as follows.
    - Chemicals feed systems are used as approved, per NR 811.232
    - ANSI/NSF 60 certification for chemicals, as required under NR 810.09 and 811.40(3).
    - Back-siphon protection per NR 811.39(2)(e).
    - Storage and handling in accordance with NR 811.40.,
    - Safety equipment is available and properly located, as detailed in NR 811.40(2)
    - Reporting accurately on electronic monthly operating reports, NR 810.07.

Verify recent intake dive inspection information related to maintenance. Verify the operating conditions of the intakes (i.e. recent cleanings, use of one intake over another, problems with frazil ice, ability to backflow intake, etc). Review SCADA screens related to the intakes and/or shore wells.

2.2.9(b) Facilities, Pumps & Controls NR 811.24 to 811.37. This section applies to facilities, pumps and controls at groundwater and surface water facilities. In addition to confirming the information below, verify all fields of the DWS Sanitary Survey Entry Point and Sources sections are completed relative to pumps information and if necessary, update. See sec. 2.2.3 for additional information.

2.2.9(b)(i) Facilities - Pump Buildings NR 811.25 Verify that pumps, pumping facilities and their appurtenances meet requirements. This applies to well houses, shore wells, wells pumps, low lift pumps, high lift pumps and in-line booster stations.

- Observe if the wellhouse / source facilities are locked and secure, including windows. Discuss with the operator who has keys, where are they stored. Identify any issues. NR 810.23(1).
- Doors are required to open out for safety, including if the facility floods. Verify that at least one door opens outward per NR 811.25(1)(c).
- If excessive pipe sweating or corrosion is observed in any of the pumping facilities, it may be recommended that the system improve dehumidification, air conditioning or ventilation, per NR 811.25(6).
- Floor must be ≥ 6-inches above ground and ≥24-inches above the regional floodplain, NR 811.25(1)(d). Check floodplain maps on DNR web viewer if questionable.
- Floor drains must be located ≥ 2 feet from the edge of the protective casing, NR 811.25(1)(h)1.
    - French drains are no longer allowed, NR 811.25(1)(h)2.d.
    - If the floor drain piping discharges at grade inspect it and verify that the pipe opening outside the building is ≥ 6-inches below building floor, ≥ 25 feet from the pump house, and the end is covered with a non-corrodible rodent screen. Recommend that the pipe discharge over rip-rap and place a stake near the opening to prevent vehicles from running over it. NR 811.25(1)(h)2.b.
    - If a floor drain is connected to the sanitary sewer, the building floor elevation must be at least one foot above the rim of the nearest upstream sanitary sewer manhole. Determine whether any recent construction may have affected this. NR 811.25(1)(h)2.a.

2.2.9(b)(ii) Pumps NR 810.13 and 811.29 to 811.37 Note, the department considers an increase in pump capacity of 10 percent or more, or an increase of 50 gpm or more between the existing operational pump capacity and the design capacity identified by the system to be a reviewable project under NR 108.02(13)(b). Prior plan review and approval is indicated for such changes in pump capacity per NR 108.03 and 811.08.

General

- Verify with the operators the date the well pump was last pulled and inspected. The department recommends inspecting the well pump every 10 years, but the system must have a written schedule or plan (NR 810.13(1)(a)).
- Discuss how the operator determines static and pumping water level.
- Discuss operation of any VFD or Soft Start. When the operator turns the pump on observe variations in flow and pressure that may affect chemical feed systems. Typically the pump discharge flow and/or pressure will decrease over time as the elevated storage fills. NR 811.34
- Verify the condition of the following at the wellhead:
    - Air-line is well sealed, with an altitude gauge or other means of measuring the water level. NR 811.36(2).
    - Well vent (at least 2 inches if the casing is 10-inches or greater). NR 811.36(1). Note: two, 1-inch vents do not have the same venting capacity.
        - Downturned U-bend or mushroom cap
        - 24-mesh corrosion resistant screen
        - Minimum 24 inches above the floor
        - Metal
    - Gravel refill and observation pipes, as necessary
        - Securely capped
        - Minimum 12 inches above the floor
        - Metal where exposed in the pumphouse
    - A secured roof hatch above the well pump for pump servicing, NR 811.25(2)(b).

Submersible Well Pump NR 811.32. Verify the following:

- Pump base height is at least 6 inches above the floor.
- Well seal consists of a sanitary surface plate bolted down with a gasketed or machined seal to a flange welded to the well casing or alternatively, a department approved well seal with one−piece top plate.
- Protective casing extends a minimum of 12-inches above the finished floor.

Vertical Turbine Pump NR 811.31. Verify the following:

- Concrete pump base is at least 12 inches above floor. NR 811.31(1)(a).
- Connection between pump head and concrete supporting base must be machined or gasketed to provide a watertight seal. Inspect the condition of the pump base. Have the operator turn the pump on manually and observe the pre-lube cycle, check valve operation, and air release discharge. Splash some water on any cracks in the base of the pump and when the pump is shut down observe any bubbles that form in the water. This is an indication that the pump base needs to be repaired. If no bubbles appear, the cracks may be superficial. NR 811.31(1)(b).

- Pump is water-lubricated. If oil lubrication is needed to keep positive lubrication verify it is NSF/ANSI Standard 61 approved mineral oil. NR 811.31(2). If there is a pre-lube line, verify the following per NR 811.31(2)(b).
    - Metered and that it is operated by a solenoid valve as necessary.
    - Pre-lube is not running continuously. Verify it is not leaking and that the valve is not manually closed.
    - Priming water is not be of lesser sanitary quality than that of the water being pumped. Verify the location this water is being pulled from.
    - Operator is accounting for all water as non-revenue water on PSC report and is minimizing the amount used as appropriate.
- Backspin protection: Verify the system has either a time delay and/or ratchet control to keep the well pump from turning back on before it stops spinning backwards. NR 811.33.

Horizontal Centrifugal Pump NR 811.30. Verify the following:

- Pump base height is elevated above floor. No minimum pump base height requirement, but 4-6 inches is typical.
- Means of removing the pump for servicing is available. NR 811.25(2).
- Means to determine low and high water level in the reservoir if applicable. NR 811.66(3)

Pump Discharge Piping - Above Ground Discharge NR 811.36 and 811.37. Pumps will typically have an above ground discharge configuration located within a pumphouse. DNR staff must check for the following appurtenances on the pump discharge piping:

- Pump to waste fitting NR 811.37(4) and 811.71(3). Discuss how water is pumped to waste and when this occurs. This is typically following pump work, but there are also situations where the pump runs to waste for a few minutes to remove iron or sulfur before pumping to the distribution system. Confirm that chemical feed systems in these cases go on once the pump to waste is over. Verify that this flow is properly accounted for on EMOR and PSC reporting. Hydrants located outside of pump house may also be used for pump-to-waste purposes. Verify flow testing from the hydrant and if necessary, discuss the need to have the hydrant painted or marked to indicate the hydrant does not meet fire flow requirements,
- Raw water sample faucet NR 811.37(5)(b)1 and 3. Ideally, this is located upstream of the check valve to be certain that only raw water is collected. Existing facilities may have raw water sample faucets downstream of check valves but upstream of any treatment. Rare installations may include chemical treatment in the well casing. DNR staff should discuss raw water sampling procedures with the operator for those installations, . Verify the sample tap:
    - Terminates at least 12-inches above the floor
    - Downturned spout
    - Metal
    - Smooth end
- Air-vacuum relief valve NR 811.37(5)(a). Air and vaccum is required on vertical turbine pump discharge piping only. An air release valve is often provided on submersible pump discharge piping. A separate air relief valve is not required if the pump discharges into a ground storage reservoir. The discharge from the valve must be:
    - Downward facing
    - 24-mesh non-corrodible screen
    - Terminates at least 24-inches off the floor

- Check valve NR 811.37(5)(c).
- Flow Meter NR 811.37(5)(d) and 810.13(2)(e). Verify that the meter is tested at least once every two years.
- Shut off valve NR 811.37(5)(e).
- Chemical injection taps NR 811.37(5)(g) and 811.39(2)(f)2.
    - Chemical injection taps may be placed between the check valve and the shut off valve except fluoride and caustic – those chemical injection taps must be after both a check valve and a shut off valve.
    - Chlorine taps must be located adequately downstream of sequestration chemical addition.
    - Polyphosphate should be located downstream of mag meters.
    - Chemical injection taps must be directed up into the bottom half of horizontal discharge piping, between the 4 o'clock and 8 o'clock positions, or injected in a vertical pipe.
- Pressure gauge is located downstream of the check valve NR 811.37(5)(f). . This allows the operator to check the pumping pressure when the well is running and check the static pressure in the system when the well pump is off.
- Entry point faucet is located after all treatment NR 811.37(5)(b)(2) and (3). The ideal entry point sample faucet is from a sample line coming off the discharge piping, before the main, outside of the pump house. If the entry point sample faucet is too close to the chemical injection taps, there will not be enough time for complete mixing of the chemical before a sample is drawn. Refer to section 6.10 of this handbook for further guidance on entry point location. The entry point tap shall:
    - Terminating at least 12-inches above the floor
    - Downturned spout
    - Metal
    - Smooth end

Pump Discharge Piping - Pitless Well Construction NR 811.35

Pitless units at municipal systems are factory assembled and pressure tested in the field. This will have been verified during a start-up inspection. In addition to the items listed in the previous section, DNR staff must check for the following appurtenances on the well and well pump discharge piping:

- Unit must terminate 12-inches above a concrete floor NR 811.35(1).
- Raw water sample tap NR 811.35(3) and (4)(a), and 811.36(2). Some units have removable sampling faucets that are stored off site when not in use, All taps shall:
    - Terminate above the top of the pitless unit and a minimum of 12 inches above the concrete floor
    - Frost−proof
    - Downturned spout
    - Metal
    - Smooth end
- Pump to waste piping NR 811.35(4)(a).
- Enclosure NR 811.35(2). The exposed portion of a pitless unit must be surrounded by a weather resistant, watertight, locked, and vented enclosure secured to a concrete floor.
- Top surface of the concrete floor NR 811.35(2). Must be located a minimum of six inches above the finished grade.
- Pressurized discharge piping NR 811.35(4)(b) and (5). Piping from the well pump to the above grade pump discharge piping must be pressurized at all times. Installations under

negative pressure can allow contaminants to enter the system. The pump discharge piping may be encased in a water tight conduit or tunnel to prevent contamination. For a similar reason, above grade check valves must normally not be located upstream from a pressure tank. A check valve between the pressure tank and a submersible pump can cause an increased risk of contamination in situations where pressure falls in buried lines before the pump kicks back on to pressurize the buried part of the system.

Booster Pump Discharge Piping NR 811.79 through 811.84
Booster pumps may also be referred to as high lift pumps when pumping from a ground reservoir or low lift pumps when discharging to a treatment train. They are commonly found in pumphouses where the source discharges to a ground storage reservoir or standpipe and a booster pump pulls the water from the reservoir and discharges it to the distribution system. Booster pumps can be either vertical turbine or centrifugal. Booster pumps are also found in the distribution system at pressure zone boundaries. These may be within pump houses or in buried vaults as "in-line" boosters. Additonal information is found in section 2.2.9(e). DNR staff must check for the following appurtenances on the booster pump discharge piping:

- Air-vacuum relief valve NR 811.37(5)(a). Air and vaccum is required on vertical turbine pump discharge piping only. An air release valve is often provided on submersible pump discharge piping. A separate air relief valve is not required if the pump discharges into a ground storage reservoir. The discharge from the valve must be:
    - Downward facing
    - 24-mesh non-corrodible screen
    - Terminates at least 24-inches off the floor
- Air-vacuum relief valve NR 811.84(9). Required on vertical turbine booster pump discharge piping only. Discharge from the valve must be:
    - Downward facing
    - 24-mesh screen
    - Terminates at least 24 inches off the floor
- Shut-off valve valve, NR 811.84(6)
- Meter, NR 811.84(3)
- Suction/discharge pressure gauges, NR 811.84(2)

Buried Suction Lines NR 811.37(1). Where well or low-lift pumps discharge to adjacent reservoirs or treatment devices like a clarifier or filter, DNR staff must check that the pump discharge piping is not draining between the check valve and the reservoir or treatment device. Buried suction lines can allow contaminants to enter the system.

Pump suction and discharge lines that are buried must be under a continuous pressure head which is greater than the elevation of the ground surface under all operating conditions to prevent the inflow of groundwater and contaminants into the piping. In situations where positive pressure greater than the elevation of the ground surface cannot be provided under all operating conditions, then the lines are typically encased in a watertight pipe conduit or tunnel. The conduit pipe opens into the pumphouse to allow operators to observe groundwater leakage into the conduit pipe.

Buried suction line installations where the lines are not under a constant positive pressure head are not permitted for new construction. Existing installations not under constant positive pressure head are typically considered significant deficiencies, NR 811.37(1)

2.2.9(b)(iii) Pump Controls NR 811.28(4). All automatic stations are required to be provided with automatic signaling equipment which will report the pump status of each pump and other important functions, such as water levels or other controlling apparatus.

Pump Variable Output Control Devices NR 811.34. Installations where pumps and pump motors are physically or electronically controlled by a variable output control device must meet the following requirements. DNR staff must verify each component and the overall operation, NR 811.34 for more information.

- A high-pressure cut-out switch may be installed. This is not always necessary depending on the pipe specifications and manner of pipe restraint, NR 811.34(2).
- A pressure relief valve shall be installed on the pump discharge piping sized to allow adequate pressure to be relieved if a malfunction that would cause the pump to discharge at the maximum possible rate would result in pressures exceeding the safe working pressures of the piping and appurtenances, NR 811.34(3).
- A flow meter capable of flow pacing any chemical feed pumps, NR 811.34(5).
- A dehumidifier or A-C equipment in the pump house is necessary to protect electronic equipment from moisture damage, NR 811.34(7) and (9).

Gate valves located on well pump discharge pipes may be used to throttle the flow from the well pump. This is not recommended because this type of operation may cause the gate valve to fail prematurely, it causes unnecessary wear on the well pump and motor, and is an inefficient mode of operation. DNR staff may recommend installing a variable frequency drive in lieu of the throttling valve.

Pump Operation and Maintenance NR 810.13 and 810.25. Prior to, or at the inspection, DNR staff should review the operating and maintenance records for all pumps, valves, meters and other controls within the pump house to ensure all design aspects of the layout remain operational. Identify any issues that may limit routine or emergency operations.

Auxiliary Power NR 811.27

- Verify that the auxiliary power is capable of providing the average day supply of water.
- Inspect documentation/log book to verify generators and auxiliary engines are exercised at the frequency required by code, NR810.13(1)(d).
- Determine if all water-cooled engine drives have been checked for proper backflow protection. See also section 2.2.9(f).
- Verify all liquid fuel storage is properly protected in either a containment basin or double-walled tank with interstitial monitoring.
- Determine any vulnerability if a portable generated is also used for other purposes, like a wastewater lift station. Discuss how the operator prioritizesz the uses.

2.2.9(b)(iv) Facilities and Pump Controls Specific to Surface Water Systems NR 811.23 through 811.37. Pumping facilities, pumps, and controls for surface water treatment systems can be complex and unique to each system. In addition to the information contained in this section of the handbook, it is essential that DNR staff understand every step of the treatment process. One of the best ways to become familiar with the treatment process and flow through the plant is to review and discuss a Treatment Process & Flow Schematic with the system operators. These schematics provide information on where pumping occurs, the purpose for pumping, where chemicals are added, the sequencing of treatment and where along the treatment train backwash water is obtained and used. Notes can be added on the schematic to

list which processes or set points trigger pumping or valve operations. This schematic should also identify the specific pump and/or basin capacities that determines the maximum treatment capacity of the surface water treatment system. Most surface water systems will have a schematic available, if not it is suggested that DNR staff develop one for future reference.

A typical surface water plant will have a shore well , sometimes referred to as low lift station. Shore wells are similar to other pump stations but have some unique properties. They rarely have a treated water service line or a connection to a sanitary service line. They may not have a floor drain and air/vacuum relief valves may discharge back into the shore well basin. DNR staff should focus on verifying that:

- All surface water pumping stations, pumphouses and water treatment buildings meet the requirements in subchapters IV and V of ch. NR 811.
- Shore well is not subject to flooding, per NR 811.23(1)(a)
- All pumps and electrical controls are above ground, per NR 811.23(1)(a)
- The department recommends that:
    - all openings are curbed to prevent contaminants from washing into the source water
    - the flow rate at the inlet of the intake is 0.25 to 0.50 feet per second to minimize frazil ice
    - screens or strainers are routinely backwashed
    - screening debris is handled appropriately, e.g. dead fish and vegetation waste is managed properly.
- Each pumping station is equipped with two or more pumping units, each with the capability of supplying the peak demand, unless there are additional pumps, or an exception has been granted by the department, per NR 811.26(1).
- Each critical treatment step has a redundant process. The primary authority to require redundancy in treatment of surface water (and groundwater under the direct influence of surface water) is set forth in NR 811.42(3), 811.43(7), and 810.31(1)(b). Additional surface water treatment redundancy requirements are established in NR 810.09(1)(b), 811.232(3), 811.45(9), 811.50(13), 811.50(19), 811.60(7).

2.2.9(c) Treatment In addition to confirming the information below, verify all fields of the DWS Sanitary Survey Treatment sections, specifically treatment objective and latest approval date, are completed and if necessary, update. See sec. 2.2.3 for additional information.

- Review the plant schematic and make updates based on file records, approvals and discussions with the operator. It may be a good idea to send an email to the head operator to confirm that it is accurate before the inspection.
- Creat a second schematic which includes approximate locations for bypass piping may also be helpful in understanding the response to emergency situations. Compare the schematic to the system's DWS treatment codes and EMOR page. Does it make sense?
- Include all chemical injection locations and all on-line analyzers and verify that the locations are appropriate and make sense. NR 809.74(2) and 810.38(2)(c)
- Address any changes to the process that did not go through plan approval. Any change meeting the definition of reviewable project in NR 108.02(13), is subject to plan approval requirements under NR 108.03. The department considers that after-the-fact review is required where prior approval of a reviewable project has not occurred.

2.2.9(c)(i) General

Chemical Feed NR 810.09, 811.38 through 811.40.

- Verify all chemical feed equipment meets code requirements, NR 810.09(1)(c), 811.38, and 811.39.
- Determine how the feed systems are controlled paying attention to VFD installations that may have variying flow rates
- Determine whether the chemical and treatment processes are currently needed and functioning as designed, NR 108.03(3), 108.06(1).
- Verify 30-day supply of chemicals is kept on hand, per NR 108.06(3) and 810.09(1)(c).
- Verify all chemicals used are NSF/ANSI Standard 60 approved for use in drinking water by looking for a label on all containers, NR 810.09(1)(c), 811.40(3). For salt stored in silos or vaults, review the most recent delivery slip or ask the operator for verification from the supplier.
- Verify all chemicals remain within their viable shelf life and any chemical in open containers is used within the 45/60-day requirements, per AWWA standards and MSDS. Ask the operator how often deliveries come and what volume is delivered, NR 810.09(1)(c), 811.40(3).
- Verify all chemicals are handled and stored according to code requirements, NR 810.09(1)(d) and (g), 811.40,
- Verify chemical is properly and accurately measured (gravimetrically or volumetrically), NR 811.39(2)(b) through (d), 811.39(4) and (6)(d).
- Verify chemical doses and chemical feeder settings are within plan approved ranges, NR 108.03(3), 108.06(1), 810.03 and 810.09.
- Verify all chemical feed equipment (type, model, capacity) has not changed since last sanitary survey. If chemical feed equipment has changed, verify that the changes have been approved, NR 108.03, 810.09, and 811.38.
- Verify injection locations are satisfactory relative to meters, valves and poision into piping, NR 811.39(2)(f).
- Verify chemical use is being reported correctly, NR 108.06(4)(a) and 810.07(2).
- Verify safety equipment is available and properly located, NR 811.40(2).
- Verify where grab samples are collected and where on-line analyzers are collecting data.

Additional Details Concerning NSF 60 NR 810.09(1)(c) and NR 809.25(4). During the sanitary survey and any time chemical use changes, evaluate each chemical used to determine if the chemical is still NSF/ANSI Standard 60 approved and if the current dosing is less than or equal to the NSF required maximum use level (as product) as shown on the NSF or WQA (alternate to NSF) websites,

Annual reporting to the Department by systems that use chemicals containing acrylamide and epichlorohydrin is required. Note, these chemicals have treatment technique requirements, not MCLs. As of January 1, 2013, Epichlorohydrin was not detected in any of the testing that NSF conducted on commercially available chemicals.

In lieu of annual reporting by the system, the following is required:

1. For those water systems using chemicals containing acrylamides, the appropriate DNR staff shall verify, **annually**, that the water system continues to use the identified chemical and that all use is below the NSF max use. <u>This can easily be</u> <u>done by using the electronic monthly operating report system (EMOR)</u>. (Formula: pounds used/(8.34 x gallons treated in millions). If the dose is less than the NSF Max Use, simply print out

the NSF web page with the product on, note the feed rate the system is using, sign and date the bottom and put in the file.

2. If the system exceeds the NSF 60 Max Use Level based on the results contained in EMOR, DNR staff must then generate a Treatment Technique Violation for the system, which requires them to public notice within 30 days (Tier 2 PN).
3. In addition to the Tier 2 PN, they are required under, s. NR 809.833(5)(d), to include the appropriate language from NR 809 Appendix A in their annual CCR. The system will need to add this manually as it will not be included in the on-line CCR the DNR generates.

Example language to include in the NON/Treatment Technique violation letter:

Our system exceeded the dose for [chemical name]. The NSF 60 Maximum Use Level for [chemical name] is [number] mg/l. Our dose was [number] mg/l on [dates]. This chemical is added during water treatment to improve the filtration process. Some people who drink water containing high levels of acrylamide over a long period of time could have problems with their nervous system or blood, and may have an increased risk of getting cancer.

Treatment Processes NR 810.09, 811.41 through 811.60

- Verify treatment process meets code requirements, see applicable portions of NR 810.09, 811.41 through 811.60
- Verify treatment matches any specific approval conditions, per NR 108.03(3), 810.03 and 810.09. and that all processes are being operated within their respective design range, NR 810.03. For example, entry point hardness/iron/manganese maximums or minimums that may be used for surrogate monitoring or radionuclides or arsenic.
- Verify proper operational monitoring test methods (i.e. Standard Methods) and procedures are followed, NR 810.06.
- Verify reporting requirements are fulfilled, NR 810.07. This may include laboratory electronic submittals and/or EMOR reporting. For example nitrate treatment requires monthly split samples reported in EMOR and DWS.
- Verify that each closed treatment vessel is opened up, where practicable, and inspected at a minimum of once every 5 years as required in NR 810.13(1)(c).
- Request operator describe operational and maintenance procedures and verify that the system is maintaining up-to-date operation and maintenance manuals for treatment equipment., NR 810.13 and 810.25.
- Verify preventative maintenance/servicing is being performed on treatment processes and associated equipment, NR 810.03 and 810.13.
- Review alarm conditions and process monitoring and discuss how operator or system responds to each alarm.
- Prepare or review schematic of treatment process with operator

2.2.9(c)(ii) Treatment Information Specific to Surface Water Systems NR 810.09, 810.27 through 810.40. This is in addition to the guidance above.

General

- Review the updates to the surface water treatment summary (completed by the plan reviewer) as necessary
- Discuss any seasonal capacity variation with the operator

- Verify all critical system components have redundancy. The primary authority to require redundancy in treatment of surface water (and groundwater under the direct influence of surface water) is set forth in NR 811.42(3), 811.43(7), and 810.31(1)(b). Additional surface water treatment redundancy requirements are established in NR 810.09(1)(b), 811.232(3), 811.45(9), 811.50(13), 811.50(19), 811.60(7). Verify there are not cross connections between the raw and finished water treatment processes (i.e. pre-filter and post-filter chorine lines interconnected) NR 810.15, 811.47(7)(e)8, 811.49(1)(d)15 and 811.862(4).
- Review elevations throughout the treatment plant to ensure all critical facilities are above groundwater level. Familiarize yourself with which installations are below grade and what's above grade.

Chemicals

- Confirm that all treatment chemicals are the same as what is on file with plan review. Specifically, filter cleaners, flocculants, coagulants and filter aids such as polymers since they are all chemicals that you wouldn't normally see reported. NR 811.38.
- Discuss in-plant emergency scenarios and responses relative to chemical storage. Verify that the local emergency response/fire department is aware of all chemcials and their use and storage locations. NR 810.23(2).
- Verify sample taps are available before and after each treatment component. Ensure that the operator is knowledgeable about the SWTR and IESWTR sampling requirements if there are problems with analyzers – i.e. turbidity grab sample every four hours at combined filter effluent, daily entry point sample, etc. NR 810.38.
- Discuss and document the operator's purpose for monitoring operational parameters to determine the knowledge of the operator. This includes: odor, alkalinity, temperature, particle counts, etc.
- Verify location of all analyzers. This includes:
    - Individual filter turbidimeter
    - Combined filter turbidimeter
    - EP chlorine analyzer
    - CT basin chlorine analyzer
    - pH EP analyzer
- Discuss the calibration and maintenance of all analyzers and laboratory testing. Determine if improvements can be made.
- Verify the values reported on the monthly report with the operator. Is it the daily max, min or average for each parameter? See the monthly report section of the handbook for requirements, and NR 810.07.
- Review past monthly reports for compliance with relevant requirements. The requirements for "beyond" conventional surface water treatment plants may be located only in documents issued by DNR Plan Review staff. For example, a system using an alternative filtration technology per NR 810.29(5), will have turbidity performance requirements unique to that system.
- Ask the operator to show you the following supervisory control and data acquisition (SCADA) screens:
    - Alarm settings - Verify that the alarm and plant shut down settings are consistent with the SWTR Summary Approval.
    - Frequency of analyzer readings for chlorine, turbidity, pH.
    - Calculations within the SCADA system for plant control. This includes CT, fluoride dosing and dosing controlled by analyzers (chlorine, ozone).

- Verify all flushing lines are properly protected against backflow/back siphonage.
- Discuss maintenance program and verify redundancy in processes to allow for continued operation during all maintenance activities, including basin cleaning. The primary authority to require redundancy in treatment of surface water (and groundwater under the direct influence of surface water) is set forth in NR 811.42(3), 811.43(7), and 810.31(1)(b). Additional surface water treatment redundancy requirements are established in NR 810.09(1)(b), 811.232(3), 811.45(9), 811.50(13), 811.50(19), 811.60(7).

Frequency of Use: Determine which processes are used continuously and which, if any, are used intermittently by evaluating the last three years of monthly operating reports. Evaluate the following:

- Pre-chlorine– changes in dosing may show additional chlorine used during lake turnover events and control of zebra mussels.
- Post-chlorine– changes in dosing may show additional chlorine used during lake turnover events and possible failures of disinfection applications earlier in the treatment train.
- Coagulant dose – changes in dosing may show additional coagulant used during lake turnover events or storms.

Monitoring Results Treatment monitoring results are reported on monthly reports to determine if all surface water treatment rule (SWTR) and interim enhanced surface water treatment rule (IESWTR) requirements are being met and DNR staff understand both the required type of monitoring and the location of the required monitoring.

- Confirm that all Giardia, Virus and Crypto inactivation parameters are continuously met, NR 810.31 and 810.33
- Verify that all monthly report required CTs are correctly calculated, NR 810.07(2) and 810.46.
- Check alarm settings and compare the settings to monthly report results to see if any alarms should have been triggered. For example, chlorine analyzers, pH analyzers, turbidity analyzers, ozone analyzers.

Intake / Shore Well Treatment NR 811.22 and NR 811.23. Discuss the following:

- Methods for dealing with taste and odor issues
- Frequency and method of maintenance of chemical feed system.

Rapid Mix/Flocculation/Sedimentation NR 811.47

- Inspect coagulant feed system, including bulk delivery process
- Discuss criteria used for changing a coagulant dose and document the process for future reference.Determine G values, minimum/maximum flow rates and retention times at both minimum and maximum flowrates.
- Verify basins are kept clean and are structurally sound.
- Verify flow is uniform, weirs are in good shape and sedimentation is occurring as expected. Address issues where sludge buildup is causing carry over of turbidity to the next process.
- Document mixer speeds throughout the processes.
- Review handling and disposal methods for backwash and sludge.
- Make sure that there are no spots where sludge is settling out prematurely.

- Foam and algae on the surface is not unusual, but there shouldn't be excessive amounts.
- Confirm what happens during overflow and verify that each process has overflow capability. Pre-filter treatment can share an overflow.
- Confirm what is done with sedimentation waste and any issues/concerns the operator has with this method.
- Check for cross connections between the sedimentation waste handling and the water treatment plant.

Filtration – General NR 811.49 and NR 811.50

- Verify curbing is provided around filter beds and hatches that open into treated water. NR 811.49(1)(d)8
- Review report from last filter media inspection and characterization
- Review typical and maximum raw and finished turbidities as well as log removal values
- Review parameters used to trigger backwashing and intervals of each step of the cycle
- Record the time or parameters used for each stage of the backwash cycle. If possible, observe a backwash including criteria used to determine frequency of backwash. Ask about manual versus automatic and if the criteria changes seasonally.
- Ask the operator if/how particle counters and turbidimeters are used to make process decisions
- Is there specific filter to waste piping installed? If not, it is highly recommended. If none, do they have turbidity spikes following backwash? What is the frequency and duration of these spikes and are these documented on the monthly report?
- Confirm what is done with backwash waste and ask if there are any issues or concerns the operator has with this method.
- Verify that the backwash pipe discharge is provided with proper backflow prevention. NR 810.15, 811.47(7)(e)8, 811.50(8) and (12), 811.862(4).
- Check for cross connections between the backwash waste and the water treatment plant.
- Review backwash recycle methods. Verify process used to ensure the Backwash Recycle Rule is met under all operating conditions, per NR 811.860.

Filtration – Conventional NR 811.49

- Look for signs of mudballs, channeling, mounds, or any other features in the sand beds that could result in short-circuiting. Recommend maintenance to address any observed concerns.
- Ask operator how long ripening usually takes and what is done with the waste water.
- Discuss media inspection and analyses procedures.
- Confirm that recorded backwash parameters both match what was approved by plan review and make logical sense.

Filtration - Membrane NR 811.50

- Review approvals and manufacturer's recommendations for membrane or cartridge filters, as applicable.
- Strainers/pre-filtration use maintenance and capacity
- Discuss module testing and fiber repair procedures (membrane filtration plants)
- In addition to backwashing processes, discuss chemical cleaning processes, including chemically enhanced backwash, maintenance wash, and clean in place.

- Discuss frequency and process for all integrity testing including: pressure decay/air hold tests, bubble tests/membrane leak test and turbidity.
- Confirm that recorded backwash parameters both match what was approved by plan review and make logical sense. Update DWS (and data forms) with any changes.

Disinfection NR 811.48

- Determine if it is possible for the contact tanks and reservoirs to be drained and inspected and/or bypassed while meeting both disinfection and capacity requirements. NR 811.42(3).
- Review emergency chlorination procedures. NR 810.26(8).
- Review location of analyzers in relation to chlorine feed points and check that the analyzer is in the appropriate location to be used for reporting. NR 809.74(2) and NR 810.38(2)(c).
- If alternate CT values were approved by the department as allowed under NR 810.46(3), review the study documentation and the approval and verify that the department-approved protocol is being followed.
- Review Long Term 2 Enhanced Surface Water Treatment Rule and Bin calculation NR 810.34 and 810.35.
- Review chlorine residual level at the entry point, verify system maintains a minimum of 0.2 mg/l free chlorine and detectable throughout the distribution system, per NR 810.31 and NR 811.42(5).
- Ensure intermediate pumping tanks and clear wells have overflows and/or high-level alarms.
- Ensure that the water used in the production facility comes from the distribution system or appropriate alternative CT requirements are met if the water used in the facility will come before disinfection CT requirements are met. This is sometimes occurs at older water treatment plants.

Other

- In some cases, there are other chemicals added to address shortcomings in the treatment process or situations unique to the plant. Discuss and document these situations. Examples include: carbon dioxide addition to increase the pH in the sodium hypochlorite feed water to reduce scale or chlorine CT on a service line immediately following filters for in-plant potable water because the plant does not have a service line following CT.
- Confirm air compressors used in various processes have 0.01 micron filters and confirm the source of air. Verify food grade oil is used.

2.2.9(d) Storage NR 811.65. This section applies to all treated water storage structures, including: clear wells located a surface water and groundwater treatment plants, CT basins, elevated towers, pressure tanks, standpipes, and ground storage reservoirs. In addition to confirming the information below, verify all fields of the DWS Sanitary Survey Storage sections are completed and if necessary, update. See sec. 2.2.3 for additional information.

Important safety note: It is the policy of the department that employees do not enter confined spaces (such as the interiors of ground storage reservoirs) nor do employees climb elevated reservoirs).

Inspections NR 810.14.

- Verify that for each storage facility, a copy of the latest reservoir inspection reports is on file and the inspection was completed within the last 5 years.
- Verify form 3300-248 is on file including any other inspection reports, pictures or video per NR 810.14(4).
- Discuss with the operator the status of all recommendations or deficiencies noted in the inspection report. Include any items remaining in the survey report. NR 810.03 and 810.14.
- Verify the operator is checking all vents, overflows and hatches annually. It is recommended that each system keep records of these annual checks, digital photo logs are helpful. NR 810.14(1).

Structure

- Discuss the adequacy of security measures at each structure including: fencing, hardened lock sets, intrusion alarms, security cameras, patrol frequency, access ladders locked and protected, locked control panels and fuse boxes. NR 810.23(1) and 811.64(2)(d).
- Discuss the adequacy of all safety measures adequate, including: availability of safety climbing devices, climbing harness, confined space protocols. NR 811.64(11).
- Determine if the lowest floor elevation of any ground storage reservoirs or clearwells are 2 feet above normal water table elevation and a minimum of 2 feet above regional flood elevation. NR 811.63(1) and(4).
- Determine if all piping connected to reservoirs remains under continuous positive pressure head which is higher than the ground surface under all operating conditions. NR811.64(5)(a) and 811.37(1).

Hatches, Vents, Overflows, Pits, Taps NR 811.64.

- Verify all hatches are properly constructed, equipped with gaskets and secured as required. NR 810.14(5) and 811.64(7).
- Ask if the operator opened all accessible hatches to verify that the hatches are functioning properly, remain water tight and are free of insect intrusion. NR 810.14(5) and 811.64(7).
- Determine if all vents are properly constructed and screened with proper mesh size. Note any material or debris on screening. NR 811.64(8).
- If a Chicago Bridge and Iron (CBI) or similar tank design is present, verify the tank been provided with a proper seal between the tank roof and access tube. Refer to Access Tube Gap Guidance document for details. During required annual inspection it is recommended that inspection of this component occur and results documented. NR 810.03 and 810.14(1).
- Verify all overflows are properly constructed and screened per NR 811.64(4). Refer to Reservoir Overflow Compliance Guidance for detail.
- Verify overflow screen mesh and integrity if accessible. Note any material or debris on screening. NR 811.64(4)(c)2 and (d)2.
- Verify the splash pad or rip rap is sloped away from the footings or foundation and that no erosion is occuring. Direct connection to storm or sanitary sewer is not allowed. NR 810.15, 811.64(3)(a)2 and 3, 811.64(4)(a)1.
- Inspect the valve pit to confirm that it is dry. NR 810.03 and 811.64(16)(c).
- Verify a sample tap and a threaded tap for chlorination purposes is installed on the connecting water main or riser pipe per NR 811.64(16)(a) and (b).

Operations

- Discuss with the operator how each storage structure is operated to prevent stagnation or freezing. For example, a recirculating pump or mixing unit is used seasonally/continuously. NR 810.03, 810.26(7), and 811.64(12) and (13).
- Determine if the reservoir can be isolated from the system and readily drained. NR 811.64(3), (4), and (6).
- Discuss the control system with the operator to verify the process is understood NR 810.03. Verify the following:
    - High and low-level alarms, summer vs. winter settings and the resulting reduction of storage volume at each level. Verify the storage volume is adequate to meet the needs of the system. NR 810.03, 811.62.
    - Discuss the operating range of the tank with the operator and ensure proper system pressure is maintained.
    - Discuss the process for making emergency changes quickly.
    - Maintenance is adequate to address seasonal water quality. For example, intentional overflow of each reservoir to address thermal stratification, pollen/debris on the water surface, etc.

2.2.9(e) Distribution Systems

Map NR 810.26(2).

- Review the the current water system map prior to the sanitary survey. If significant changes have occurred since the map was printed, updated maps must be requested at the sanitary survey. Two copies, ideally one electronic pdf copy for the plan review engineers and one paper copy for field engineer, satisfies the requirement. One copy of the map is kept at the regional office and one copy is kept at DNR's central office in Madison.
- The map shall include the following: size and location of all facilities and appurtenances, such as water mains, valves, hydrants, wells, pumping stations, booster stations, treatment plants, storage facilities, overflow elevations of system storage facilities, and pressure zone boundaries. Additional items often included on maps but not specifically required by code are booster stations, PRVs, blow offs, interconnections, surface water crossings, railroad crossings, and highway crossings. NR 810.26(2).

Mains 810.03, 811.69(1), 811.70(1), (5), and (7), and 809.119 (materials inventory requirement).

- Verify all water mains are made of approved materials, according to NR 811.69(1), and of sufficient size. If water mains are in use that are not made of approved materials, consider noting these as nonconforming features. If the main sizes are insufficient document these as nonconforming features in the sanitary survey report.
- Discuss the water system's standard procedures for repairing water main breaks. Inquire who repairs water main breaks and how soon breaks are repaired after being discovered. Ensure that bacteriological samples are collected if the system does not have continuous disinfection. NR 810.03, 810.06, and 810.13
- Verify that all water mains are adequately separated from sewerage components, both vertically and horizontally, including sewer manholes. No water pipe may pass through or come into contact with any part of a sanitary or storm sewer manhole. Sanitary sewer

force mains must be at least eight feet from water mains. NR 810.15, 811.74(2), (3), (5) and (6).

- Verify the water system is designed properly so that there are no "flow through" situations within the distribution system (multiple connections to private property, mobile home parks, schools, large commercial or industrial buildings, etc). Water mains that are connected to the public distribution system at more than one point may be privately owned and maintained provided that a check valve is installed on the water main at each point of connection to the distribution system to prevent water from flowing back into the distribution system. Each check valve must be located in a manhole or vault and must be immediately preceded and followed by a buried or exposed shut-off valve on the main. The water supplier must have access to the manholes and valves for inspection purposes. NR 811.68(3). For further guidance concerning privately-owned, looped water main systems attached to municipal systems, are located several pages down.
- Verify that water mains crossing under water courses greater than 15 feet in width are provided with valves on both ends of the water crossing. The valve closest to the supply source must be in a manhole. Permanent taps must be made on the pipe within the manhole on either side of the valve to determine if there is leakage in the water main crossing. If the supply side valve is not in a vault, this should be noted as a nonconforming feature. NR 811.76(2).
- If minimum static pressures of 35 psi are not provided at all points in the distribution system at street level, a booster station may be installed or individual pressure boosting systems on each service line may be installed if there are less than 10 individual pressure boosting stations in any given service area. If individual pressure boosting systems are utilized, verify that they are being maintained by the water system owner. NR 810.03, 811.70(1) and (4), 811.81.

Materials Inventory NR 809.119. All water systems are required to have a comprehensive inventory of all materials in existence in the distribution system, including service lines on both the customer side and utility side, and customer premise plumbing; for corrosivity characteristics. The material inventory is also used for picking sites for lead and copper sampling, according to NR 809.547(1).

- Verify that the system is maintaining a materials inventory list.
- Verify that the inventory is updated based on cross connection inspections, meter changes and construction projects.

Pressures NR 810.11 and 811.70(4). Confirm that the static pressure range in the distribution system is between 35 and 100 psi at all locations under normal operating conditions.

- Confirm that a minimum residual pressure of at least 20 psi is maintained at all points in the distribution system under fire flow conditions.
- Confirm the utility responded adequately if there was a pressure loss affecting 25-percent or more of the water system.
- Remind the water system to report to the DNR and begin a boil water notice any time pressure is lost in more than 25-percent of the distribution system, per NR 810.12.

Hydrants Wis Adm. Code § NR 810.11 and 811.70(5).

- Confirm that all water mains serving fire hydrants are at least 6-inches in diameter. If smaller mains are present, determine if fire flows can be met or if customers can be adequately served by a nearby hydrant from a larger main. Larger mains may be

necessary to allow the required fire flow while maintaining a minimum residual pressure of 20 psi at ground level at all points in the distribution system

- Determine if the utility has a program to replace under sized mains. This can be confirmed by reviewing the annual PSC reports.
- Review the latest fire flow study to determine if all fire hydrants can produce 500 gpm at 20 psi residual pressure at ground level at all points in the distribution system, NR 810.11 and 811.70(6).
- Where hydrants exist that provide insufficient flows, verify that the hydrants are color coded or tagged, NR 811.71(3). Verify the fire chief has been notified in writing of the locations of those hydrants, NR 811.71(3). Determine if a recent fire flow study has been made and if the most recent fire flow study reflects existing conditions, NR 810.11. Verify dead-ends have been minimized and the water mains are looped to the extent possible, NR 811.70(8) and 811.68(3). Verify that where dead-ends exist, approved flushable devices are provided, NR 811.70(8). Determine if isolated service areas have been minimized or eliminated. If there are isolated service areas, recommend corrective action, such as having at least two mains crossing for items such as rivers, railroad tracks, or interstate highways. Determine if the hydrant flushing schedule meets the minimum requirements for system hydrants and for dead-end hydrants, NR 810.13(2)(b) and (d). More frequent flushing is required in areas of poor water quality, NR 810.13(2)(d). Adequate records need to be kept of all water used for flushing, fire department use, and street maintenance, NR 810.13. Verify that hydrants identified as inoperable or leaking are promptly repaired or replaced, NR 810.13(2)(c).

Valves NR 810.13(2).

- Determine if the valve exercising program is adequate. Unless an alternate schedule is approved by the department, all distribution system valves are to be exercised a minimum of every 2 to 5 years. Hydrant lead auxiliary valves are recommended to be exercised a minimum of every 5 to 7 years.
- Verify that valves identified as inoperable or leaking are promptly repaired or replaced.
- Verify record keeping sufficient to ensure proper scheduling is required under § NR 810.13. It is recommended that each system maintain records sufficient to document completion of these valve and hydrant exercising and maintenance requirements. Further, it is recommended that each system maintain records on maintenance for all hydrants and all valves, including accurate locations. At a minimum, we recommend that records show the hydrant or valve number, date of flushing or exercising and comments. Written location descriptions or sketches are also preferred. NR 810.13.

Losses (non-revenue water) NR 810.18. Water losses for the water system should be minimized and should be less than the maximum amount for that size water system, as established in PSC 185.85. Water losses are reported in the annual PSC reports. To ensure that the system is minimizing water losses, verify that the system: conducts periodic leak detection studies, maintains accurate records of hydrant flushing and fire department use, tests well meters every 1-2 years, meters prelubrication lines at wells or operates with solenoid valves; and tests or replaces customer meters at the frequencies stated in PSC 185.

Water Loading Stations NR 811.78. If present, must be designed properly to prevent contamination of both the public water supply and each vessel being filled. Backflow/backsiphonage protection needs to be provided. Free air breaks are preferred over reduced pressure principle backflow preventers. Some systems require a supervised fill to

assure that proper backflow protection is used and that the water is properly accounted for. Hoses must not be contaminated by contact with the ground. Water meters are recommended to be installed on the piping.

Booster Stations

- Verify booster pumps are equipped with an automatic cutoff control that will stop the pumps when the suction pressure falls below 20 psi, NR 811.81(4).
- If no elevated storage is provided in the boosted zone, the booster station must be equipped with a continuously running pump to maintain pressure in the boosted zone or a small bladder type hydro-pneumatic tank with a 3-minute minimum run timer on the pump must be provided, NR 811.81(6).
- If a booster station serves more than 50 living units and an emergency power source is not provided, elevated storage must be provided to serve the boosted zone, NR 811.82(2).
- If a boosted zone serves more than 50 living units and cannot maintain pressures over 20 psi from the main system and does not have elevated storage in the boosted zone, emergency power must be provided for the booster station, NR 811.83. DNR staff should recommend an automatic transfer switch on the generator if not present. The on-off operation of the booster pumps and the system pressure at the booster station must be monitored at one of the main pumping stations, other waterworks facilities, or wherever the master control panel is located, NR 811.84(1).
- At stations serving 50 or fewer living units, monitoring may be provided by a light or an audible alarm placed in a conspicuous location outside the station to indicate pump failure, NR 811.84(1). A loud audible alarm is recommended because people tend to ignore the lights. The booster station must be equipped with pressure gauges on the suction and discharge lines, NR 811.84(2). The pumping units in a booster station must be capable of being automatically bypassed when the pumps are not operating, NR 811.84(5). The booster station must be capable of being bypassed when the station is not in service, NR 811.84(6). The booster station must have adequate heating, ventilation and dehumidification equipment installed NR 811.84(7), (8), and (9).

Privately-Owned, Looped Water Main Systems Attached to Municipal Systems NR 811.68(3). Within municipal water systems it is not uncommon to find private water mains improperly connected to a municipal water system at two or more locations. This situation allows water to flow through the private mains back into the regulated public water system. This guidance was developed to help DNR staff and municipal water system staff determine the best course of action when a privately-owned system is found to be connected to the municipal system at more than one location or when this situation is proposed as new construction.

It is a common engineering practice to connect privately-owned mains to the municipal system at more than one location to provide adequate fire protection as well as add redundancy. In addition, some municipalities rely on the additional connections to the private distribution systems to improve hydraulics and water quality in the municipal water system. The most common type of privately-owned main is a store complex or a business that maintains their own distribution and fire protection piping. All of these pipes and plumbing are subject to DSPS 382 when installed.

The reason that these privately-owned systems are not considered public water systems is because they meet all exemption criteria of NR 810.01. Therefore the requirements in NR 810

are not applicable.

> *NR 810.01 Applicability. This chapter governs the general operation and maintenance of all public water systems, unless noted otherwise within each section. This chapter shall apply to each public water system, unless the public water system meets all of the following conditions:*
> 1. *Consists only of distribution and storage facilities, and does not have any collection or treatment facilities.*
> 2. *Obtains all of its water from, but is not owned or operated by, a public water system to which such regulations apply.*
> 3. *Does not sell water to any person.*
> 4. *Is not a carrier which conveys passengers in interstate commerce.*

History

Privately-owned, looped systems have always been a concern to the Department because these private systems may not be designed, constructed, operated, or maintained properly and this could change the water quality and sanitary condition of the water flowing back into the municipal water system. In addition, the Department has no legal authority to require water utilities or the system owners to operate or properly maintain the private system to protect water quality. The 1974 code language (NR 111.24) noted, "All mains on private property which are or in the future may be connected to the distribution system thereby allowing flow through the piping system shall be owned and maintained by the waterworks owner". Over time, inspections by DNR staff found that the code was not being adhered to and many communities had areas where private main was looped into the municipal system.

In 1992, to address these existing situations, the Department implemented a code change - check valves would now be required at each connection to the municipal water main. Check valves would provide some level of protection by minimizing the potential for degraded water from flowing back into the municipal water system.

Implementation of the code requirements is carried out through the sanitary survey inspection process. Water systems make corrections to comply with the code requirement when identified. Over the years there have been several objections that have been raised by the water systems when the Department has required corrective action.

- Check valves are not a recognized backflow protection device for private plumbing systems regulated by the Department of Safety and Professional Services. In addition, the appropriateness of the DNR to require their use for backflow protection has been questioned since there is no way to know if the check valve is working properly. To address this, the Department added the following note to NR 811.68 (3), *Note: a drain fitting may be added on the piping between the check valve and the gate valve on the municipal water side of the check valve. The gate valve may be closed and the drain fitting opened to periodically check for leakage through the check valve. Refer to SPS 382.40 for standards for the construction of private water mains.*
- If they choose to take ownership of the private system, the water utility will need to operate, maintain, and eventually have to replace the water main at the end of its life. This can be an expensive proposition and the design may not be to municipal standards.
- Some privately-owned systems were designed, constructed, and are being
- operated and maintained by the water supplier without their taking ownership. In some cases, this arrangement has been going on for a long period of time but is a violation of NR 811.68(1).

In December 2010, the applicability section of Chapter NR 811 was changed to limit the Department's ability to impose the standards of NR 811, "on a case-by-case basis" to facilities in existence on December 1, 2010, when the Department determines that a health risk exists due to the water system, NR 811.01.

Corrective Action Requirements

1. For privately-owned, looped systems identified prior to December 1, 2010, the water system must complete one of the following:
   a. Privately-owned distribution system owner or municipality installs required check valves at each connection in accordance with NR 811.68(3).
      i. Prior SPS approval is required, SPS 382.20(1)
      ii. The water supplier must have access to manholes and valves for inspection purposes, NR 811.68(3).
      iii. Fire flow testing on hydrants on public and private sides of the loop is recommended following installation of check valves.
      iv. It is recommended that if the water supplier is conducting the maintenance they should have a legal agreement in place for billing purposes and access to the property. It is recommended that liability protection and insurance cover this arrangement.
      v. It is recommended that DNR staff request specifics on where and how valves will be installed. Periodic inspection and testing of these valves should be included in the overall system maintenance per NR 810.13.
      vi. If there are concerns that a check valve may not work properly, the water supplier can require a check valve with an atmospheric vent or a reduced pressure zone backflow protection device. While an unseated check valve may not completely eliminate backflow risk, it will significantly reduce it. This is deemed an acceptable device by the Department at this time.
      vii. If there is a concern about over-pressurization within the private system due to the check valves, it is recommended that the owner install pressure relief valves. In large systems this is not likely to be a problem because there is usually a fixture open at all times and most pressure fixtures have individual pressure relief valves at the fixture.
   b. Municipality takes ownership of the privately-owned distribution system.
      i. Prior DNR water main approval is required, NR 108.03. Water lines, valves, and hydrants must meet NR 811 requirements for design, materials, and installation, NR 811.70. The Water Main Approval Form 3300-66 shall be submitted and shall include a copy of any previous approvals issued by Department of Safety and Professional Services (formerly Commerce). In addition, the utility shall identify how they have control over the water main – easement or street ownership, NR 811.68(2).
      ii. Water main map must be updated and provided to the Department, NR 810.26(2). Water mains are subject to fire flow requirements in NR 811.70(6) and the requirement to maintain current fire flow studies showing the fire flow capability of the system, NR 810.11.
   c. Private system owner truncates the loop by capping the main and installing hydrants or flushing devices on each newly created dead end.
      i. Prior SPS approval is required, SPS 382.20(1).
      ii. It is recommended that the owner conduct modeling and/or field testing to strategically locate the cut to ensure good fire flow in both segments.

iii. It is recommended that fire flow testing on the remaining legs of the private system be completed once the cut and capping is complete to ensure adequate flows to the structures that are served by the remaining private system.

2. For privately-owned, looped system existing on or prior to December 1, 2010, not identified as a violation under the previous code, the Department allows the non-compliance to remain unless a known public health risk exists per NR 811.01 or it becomes a reviewable project in the future per NR 108.03. Public health risks are evaluated on a case by case basis. Water borne illness, water quality complaints, positive bacteria sampling, cross connections, and potential for contamination are considered when determining public health risk.
3. For privately-owned, looped systems approved by DSPS and constructed after December 1, 2010, where the piping was approved by DSPS, without the required check valves, the deficiency should be identified and the requirements in paragraph 1, above, must be met, per NR 811.68(3)

Reasonable timeframes to return to compliance

The timeframe to return to compliance is made on a case-by-case basis, but in general DNR staff should consider the following when setting deadlines.

- Situations involving owners that have a budget cycle (universities, technical colleges, large industries, etc.): the timeframe should be no more than two budget cycles.
- Situations involving condominiums, gated-communities, etc.: the timeframe should be no more than 1 year.
- Situations involving commercial development involving more than one entity: the timeframe should be no more than 2 years.
- In order to spread out the costs, additional time can be allowed if the owner has more than 2 connections to address and a corrective action plan is submitted and approved by department.

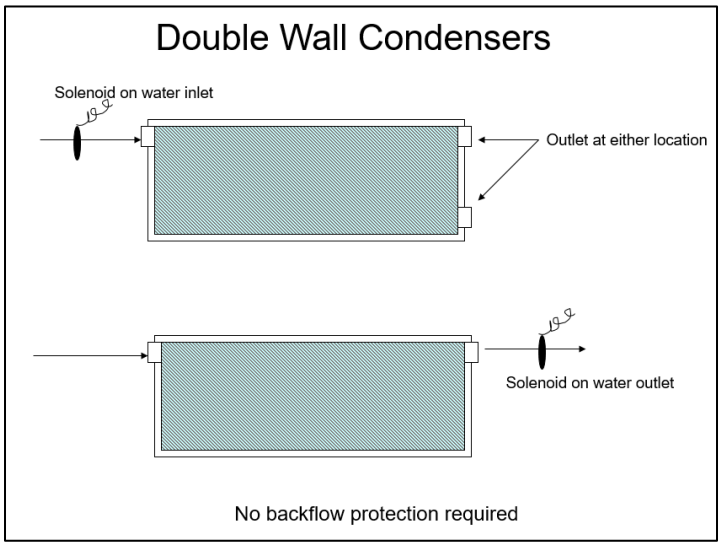
2.2.9(f) Operations and Management

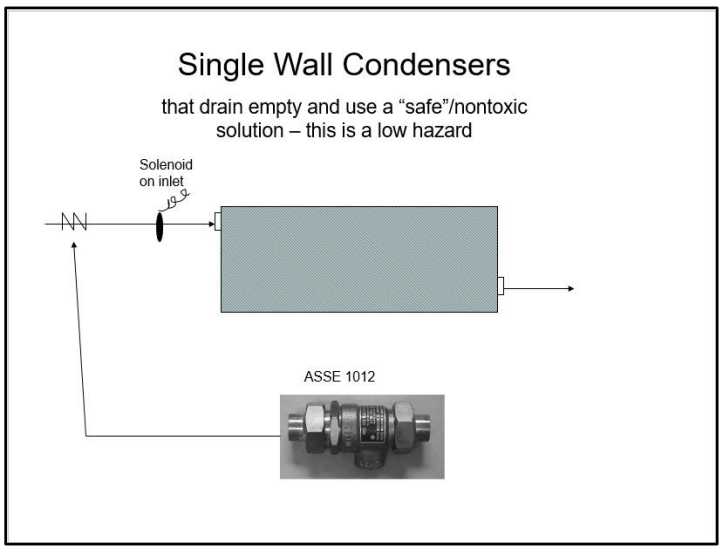
Cross Connection Program NR 810.15(1)(a) through (f). Verify the following:

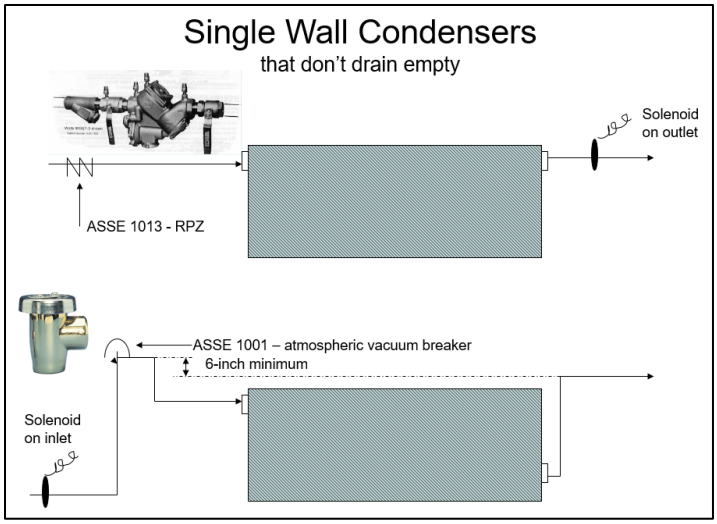
- Written administrative procedures/plan contains required elements and are adequately described: inspection agent(s), inspection schedule/frequency, enforcement process, public education program, and DSPS Plumbing Code reference.
- Ordinance or other governing rule is current. Review the ordinance or other governing rule to ensure all requirements of NR 810.15 are met. A model ordinance is available in s. 3.2.5 of this handbook to assist systems with development of their cross connection control program.
- Cross connection inspections evaluate facilities to the last flowing tap or end-use device. A review of a representative number of survey forms shows inspections are comprehensive and well documented.
- Annual summary reports are filed on time and filled out completely
- Review follow up of violations. Make sure the system is enforcing established time limits as outlined in their ordinance.
- Inspection frequencies are met on time.
- If partial home surveys are done, an education brochure is provided to the homeowner during each inspection and is also mailed to all customers every three years.

Cross Connections Within Water System Building NR 810.15.

- Verify the water treatment plant is included in the cross connection control program and has been inspected. NR 810.15.
- All internal and external hose bibbs must have a hose bibb vacuum breaker installed.
- Pre-lube lines do not require backflow protection.
- Auxiliary engines that are water cooled are required to have backflow protection, see example configurations below, NR 810.15. Because it is often difficult to determine whether condensers are single wall or double wall, you may need to rely on the operator's knowledge of the system.







Private Well Permitting Program NR 810.16. Verify the following:

- Ordinance or utility rule is in place to ensure all the requirements of are met. A model ordinance is available in s. 3.2.5 of this handbook, to assist systems in developing a local well regulation program.
- Review ordinance to determine the scope of their permitting program. Some communities permit all wells within their limits, regardless of whether the customer is on their water system or not. Make sure they are applying their ordinance consistently. Point out inconsistencies.
- Private wells located on properties connected to the water system have a current (non-expired) permit.
- Permits are issued:
    - Every five years or less
    - At least one negative bacteriological sample is on file. NR 810.16(2)(a).
    - Passed an inspection by a licensed pump installer or well driller within the last 5/10 years (depending on how their ordinance is written) and a completed DNR Form 3300-305 is on file. NR 810.16(2)(b) and 812.42. Review well inspection forms to make sure the well is fully compliant.
    - Has no cross connection between the well and the municipal water system. NR 810.16(2)(c).
- Verify unused, unsafe or non-complying wells are filled and sealed. NR 810.16(2)(b) and 812.26.

Well Head Protection Program NR 811.12(6).

- Verify a well head protection plan in place for all new wells constructed after May 1, 1992, per NR 811.12(6). Recommend developing one that includes all wells.
- Verify an ordinance or zoning requirement is available and being enforced. Discuss who is responsible for this and whether they are aware of the plan and ordinance.

Note, the department considers all well head protection plans "reviewable projects" under NR 108.02(13)(b), subject to plan review under NR 108.03.

Emergency Operations Plan (EOP) NR 810.23(2).

- Verify that routine updates are made (emergency contacts and phone numbers)

- Verify the EOP is routinely reviewed/practiced
- Review emergency chlorination plan and procedures, included in EOP
- Review auxiliary power procedures and emergency water provisions, included in EOP
- Ensure EOP includes standard procedures for emergency water production, as required by NR 810.23(2)(a)4.
- Confirm emergency drinking water kit is available and properly stored (if one is located at the site) and review location of nearest kits with the operator.

Meter Testing Program NR 810.13(2)(e).

- Verify source/well meters are tested every two years, including magnetic meters
- Check that all meters are tested within PSC requirements stated in PSC 185.
- Discuss with operator that inaccurate readings from large meters in the system can be a source of a greater percentage of water loss.
- Verify meter records are complete (meter age, location, and last tested).

Security Measures NR 810.23(1). Confirm all water system facilities are protected with multiple barriers to prevent unauthorized access.

Review Past Deficiencies, Recommendations, Non-Complying Features Verify:

- Deficiencies corrected within deadlines
- Recommendations implemented as appropriate
- Upgrades constructed within plan approval requirements
- Providing a summary of previous corrective actions may be helpful

Capacity Wis. Stats § 281.17(9). Discuss and verify all aspects of the following categories of capacity. For additional guidance on capacity determinations see s. 2.2.11 of this handbook.

Financial Capacity

- Annual budget and budgeting process
- Revenue sufficiently covers expenses (positive net operating income, as reported on page F-23 of the annual PSC reports)
- Return on rate base is positive (as reported on page F-23 of the annual PSC reports)
- It is recommended that the last three annual PSC reports be reviewed to check for trends
- Timely rate increases
- Non-revenue water and total water losses are minimized and below DNR/PSC requirements, NR 810.18

Technical Capacity

- Facilities and treatment are properly operated
- Operator(s) technical knowledge is adequate
- Infrastructure (source, treatment, distribution and storage) is adequate
- Monthly operating reports completed correctly and submitted on time

Managerial Capacity

- Clear ownership and accountability
- Management supports proper operation and preventive maintenance measures
- Adequate staffing and equipment to complete all tasks required to operate and maintain the water system

- Assets reviewed and prioritized for upgrade or replacement
- Capital improvement plans in place and being implemented
- Projects subject to formal plan approval under NR 108.03 are submitted for department review and approval prior to construction.
- DNR staff are notified of project completion and written start up authorization is obtained prior to placing new facilities in service. NR 810.26(1).

Customer Complaints The department recommends water systems maintain records of customer complaints and water utility response actions. If available, review records to identify any concerns that warrant additional investigation or action.

Enforcement Actions

- Review any monitoring rule and notification violations documented in a letter of notice of noncompliance.
- Review any maximum contaminant level and treatment technique violations documented in notice of violation.
- Public notices have been issued for monitoring rule violations, maximum contaminant level violations and treatment technique violations.
- Conditions of orders (consent or administrative) and compliance agreements have been met within applicable deadlines.
- A summary of previous enforcement actions and corrective actions may be helpful. State if the system is back in compliance. Tables may also be helpful.

2.2.9(g) Monitoring and Reporting Additional surface water specific operational monitoring and reporting requirements can be found in NR 810.38 and 810.39. In addition to confirming the information below, verify all fields in the DWS including: the information listed in DWS for sources, entry points, treatment, treatment objectives and populations served and make updates, as necesssary.

- Verify that the information being reported in the Electronic Monthly Operating Report (EMOR) is correct and that all required information is being reported. Refer to Section 3.3 of this document for more information on EMOR review and reporting requirements. Refer to Chapter 7 of this handbook for guidance if changes to EMOR reporting pages are needed.
- Review the current monitoring schedule with the operator.
- Encourage operators to collect samples early in the week and early in the monitoring period to avoid potential monitoring and reporting violations.
- Review monitoring site plan with the operator. Verify that approved sites have been identified for all required monitoring and that all sites on the monitoring site plan meet the criteria found in Section 3.7 of this handbook. When possible, field verification of sample faucet type and location should be made.
- Verify operator is taking water samples for coliform determination at regular intervals each month, at geographically representative locations, and on dates evenly spaced during the month. We recommend that systems rotate sample sites on their approved bacteria monitoring site plan. Per NR 809.31(1), the sites selected for sample collection should be chosen such that samples represent the water quality throughout the distribution system.
- Have the operator describe the sampling protocol used for each type of sample collected to verify that the sampling protocol conforms to EPA guidance. Refer to the EPA “Quick

Guide to Drinking Water Sample Collection" for information on appropriate sampling protocol.

- Verify that on-site laboratory equipment used by the operator is appropriate, maintained and properly calibrated.
- Make sure operator has appropriate grade for the treatment such as HMO/iron removal, VOC, etc. See s. 2.2.9(h) of this handbook for further details concerning operator certification.
- Review the system's disinfectant residuals and their disinfectant residual testing equipment.
- Verify operator access to a set of calibration standards and have calibration records showing that the colorimeter is regularly checked against those standards. If the utility has their own standards, DNR staff should verify that the standards have not expired.
- Discuss with the operator the following note published in NR 810.09(2), especially at systems that do not continuously disinfect.

> *It is recommended that all community water systems provide a detectable disinfectant residual throughout the distribution system. When disinfection of water drawn from a groundwater source is required in order to maintain bacteriologically safe water, the residual maintained in the distribution system and the residual monitoring shall be as required in NR 809.74 (2) and 811.43 (2). Additional disinfection requirements including disinfectant contact time or compliance with the disinfection requirements of NR 810.31 (1) may be required by the department on a case-by-case basis. The following conditions, as well as other conditions, are considered by the department to be existing or potential water system public health threats:*
>
> *1. A public water system history of microbiological contamination in the water source or distribution system by either coliform or noncoliform bacteria.*
> *2. The presence of color in raw water from a well serving a public water system.*
> *3. Inadequate construction, including construction which does not meet current requirements of ch. NR 811 or 812, of a well which serves a public water system.*

- Verify the SPADNS colorimetric method is not used to measure fluoride residuals for systems feeding phosphates, due to interferences. Systems using phosphates must use the ion-selective electrode method to determine distribution system fluoride residual, per NR 811.51(7).
- Large distribution systems and/or multiple sources, may require more than one fluoride residual test per day to assure proper feed rates, per NR 809.74 (1)(b)3.
- Recommended the system quantify their raw water fluoride levels to help ensure proper dosing.
- Split fluoride samples are required to be submitted monthly by fluoridating water systems to verify that their instrument is accurate, see CDC Fluoridation Engineering and Administrative Recommendations for Water Fluoridation (1995). Variance of 0.2 mg/l or more between lab value and operator value warrants additional investigation. The optimal fluoride range 0.6 to 0.8 mg/l, therefore, at a minimum, the fluoride residual monitoring method needs to be within $\pm$ 0.2 mg/l to provide useful information for the operator.
- Remind operator of the requirement to notify the department any time they fail to meet any department-specified requirements, which includes minimum disinfectant concentrations. This notification must take place as soon as possible, but not later than the end of the next business day, per NR 809.329. Furthermore, under NR 108.06(1), if operating difficulties or mechanical breakdown of plant units results in impairment of treatment effectiveness, the water utility is required to notify the department immediately.

- Discuss current contaminant levels, the impact of any treatment being used and any trending that is taking place. DNR staff may also consider discussing any Unregulated Contaminant Monitoring Rule (UCMR) monitoring that the system may have done recently.
- Discuss additional monitoring conducted by the system for operational use. Although reporting these values is not required by the department, any monitoring done that could result in operational changes must be kept on file at the utility. If optional monitoring does result in operational changes, it is important for DNR staff to understand the role these values play and be able to verify that reporting these values to the department is not required. During the survey, DNR staff should specifically ask if optional monitoring is taking place and what purpose it serves.
- Review any monitoring or reporting violations and discuss improvements in the program to prevent any future violations.
- Review public notice requirements generated within the past few years and whether or not the utility met those requirements.
- Discuss the process for notifying home owners of their lead results, specifically the timeline for notifying customers when a sample from their home is above the Action Level. A utility must notify customers of their lead results as soon as practical, but no later than 30 days of the utility learning of the results, per NR 809.541(9) and 809.546(4)(b). Nevertheless, the Department strongly encourages systems to notify customers with results above the action level within 24-hours of learning the results, Timely notification enables customers to take actions to mitigate their exposure to lead in drinking water.
- Discuss other testing being used for reporting purposes that is required to be conducted using the approved test method. This includes performance testing (also known as check samples or running standards to verify test method and meter accuracy). Specific methods for each parameter are identified in NR 809.

2.2.9(h) Operator Compliance NR 114, subchapters I and III. In addition to confirming the information below, verify all fields of the DWS Operator Certification page for expired licenses and assigned Operators-In-Charge (OICs) for each subclass are correct and completed and if necessary, update.

2.2.9(h)(i) General Operator Compliance NR 114.29(3). Discuss the following with the operator and/or manager:

- Verify water system staffing and operator certifications
- Verify that operator contact info is correct, see pre-survey report.
- Discuss the designated “operator-in-charge” (OIC) for each subclass at the system and ensure this is reflected correctly in DWS. Ensure that the designated OIC is available during each shift and present to provide supervisory oversight of other water system staff. Discuss coverage during vacations, injuries and illnesses. A certified operator must be available. NR 108.06(2), 114.30, 810.04(1), and 810.27(4).
- Review the list of operators shown in DWS. Ensure the list is up to date.
- If there are operators with an Operator in Training (T) designation, discuss the process of upgrading the certification to Grade 1 with 12 months of applicable experience and submittal of an experience form 3400-066B.
- Continuing education requirements. It is preferable to have the water system encourage the operators to attend continuing education by paying for, or reimbursing the operators, to become, or remain fully certified. If this is not done, managerial capacity may be

lacking, Wis. Stats § 281.17(9). Although only one certified operator is required, having multiple operators fully certified is encouraged to provide qualified back-up on weekends and vacation coverage and to avoid a violation if the certified operator should leave.
- License expirations and renewal requirements
- Mention the fact that Operator Certification exams are now offered quarterly (formerly they were offered bi-annually)
- Mention the DNR OpCert Event Calendar, which is a calendar that includes a broad range of upcoming continuing-education training and courses for operators in various locations around the state https://dnr.wi.gov/elcpublic/EventCal.aspx?pc=1#.WyAjS4pKiUk

2.2.9(h)(ii) Surface Water System Operator Compliance 114.12(2)(d).

Surface water systems are required to have an operator with a current surface water certification on duty at all times when the plant is operating, but not necessarily on site. One possible way to satisfy this requirement is to have an auto dialer connected to a SCADA which would contact the on-duty operator if any issues arise.

This may also be a good time to inquire about any operator specialties. For example, if you have an operator that does all the EMORs, it may be easier to just email that operator and copy the head operator in the future.

2.2.9(i) Review Findings

Best practices for reviewing findings include the following:
- Review preliminary findings with the operator and utility manager during the closing discussion of the sanitary survey. This is usually conducted at the system office but can also be done through a follow-up phone call if the utility manager is unable to attend the inspection. Discuss a plan and schedule for corrective actions. See s. 2.2.1.e for guidance on corrective action plans and schedules. Identify whether plan review is required for the corrective actions identified.
- For significant deficiencies, inform the system representative(s) of the deficiency as soon as possible, either at the time of the sanitary survey or upon identification of the significant deficiency. In severe cases, immediate or interim measures to protect public health may be needed.
- Deficiencies from prior surveys that are found to be unaddressed at the current survey are to be escalated to significant deficiency, or managerial capacity significant deficiency, also referred to as “management and operations” significant deficiency. A significant deficiency that is not resolved by the agreed upon deadline becomes a treatment technique violation, triggering enforcement under NR 809.328.
- Complete the Checklist in the DWS sanitary survey screen, then enter the significant deficiencies, deficiencies, recommendations and nonconforming features. In DWS, link the significant deficiencies and deficiencies to PWS actions, including corrective actions with deadlines.~~DWS~~ (see s. 2.2.3 (c) & (d)).
- Insert annotated photos into survey report as needed.
- Distribute the final survey report/letter to the system within 30 days of the site visit, including a proposed corrective action plan and schedule. In some cases, it is helpful to

offer to present survey findings to the water system oversight board or commission, and explain the corrective actions required.

- Post the PDF version of the signed letter electronically, in accordance with current e-record storage practices. File a paper copy in the system case file, in accordance with current record management practices.
- Monitor correction of deficiencies and update DWS upon completion. Depending on severity, weekly contacts may be warranted to monitor correction of significant deficiencies. According to EPA guidance, the state should make regular and continued surveys of the facility until all significant deficiencies have been corrected.

2.2.10 Capacity Evaluation (1/12/11)

Sanitary surveys are the primary tool for evaluating the technical, managerial, & financial capacity of all existing public water systems. As such, a determination of system capacity should be an integral part of every sanitary survey. Deficiencies noted in any of the eight elements can cause an inspector to determine that the system is not meeting capacity. If it is determined that a system does not meet technical, managerial, or financial capacity, inspectors should indicate "no" in the "Capacity" field of the System Evaluations Summary table on the sanitary survey screen of the DWS. Marking "no" will cause the DWS to insert the following language into Assessment letters for community and non-transient non-community systems:

> "This sanitary survey serves as an evaluation of the capabilities of your water system. This system has been determined to have **inadequate** technical, managerial, and financial capacity to provide safe drinking water. The ability to plan for, achieve, and maintain compliance with applicable drinking water standards has not been demonstrated."
>
> "Your system has been determined to have **inadequate** technical, managerial, and financial capacity because:
> - Enter reasons here."

Most systems will only be lacking in one area of capacity (technical, managerial, or financial) so the inspector should include only the appropriate choice of the three options in the letter, i.e. "… inadequate technical capacity…"

Technical Capacity: A system may be determined to have inadequate technical capacity if there is inadequate supply, infrastructure, or technical knowledge. The supply should be adequate to meet current and future demands and be protected from contamination. The infrastructure (well, storage, distribution system, treatment, pumphouses, etc.) should be in good condition without deficiencies. Operators should have the appropriate technical knowledge to manage the system.

Managerial Capacity: A system may be determined to have inadequate managerial capacity if there is a lack of staffing and ownership accountability. Owners should be clearly identified and accountable for the PWS. The system should have the proper number of operators and managers with expertise to run the system at any point in time. There should be standard operating procedures established and followed.

Financial Capacity: An evaluation of the financial capacity of a system is done very differently depending upon system type. Community and non-transient non-community systems have very clearly defined survey questions regarding adequate revenue, budget, and infrastructure replacement plans. As such, any "no" answer to one of these questions should indicate inadequate financial capacity. Inquiring about finances at TN systems is often an awkward situation. There are no specific financial questions on the TN sanitary survey however, it is important that inspectors discuss potential infrastructure replacement costs with TN system owners. Considerable judgment is used when determining if a system does not have financial capacity.

Marking "yes" will cause the DWS to insert the following language in the Assessment Letter:

> "This sanitary survey serves as an evaluation of the capabilities of your water system. This system has been determined to have **adequate** technical, managerial, and financial capacity to provide safe drinking water. The ability to plan for, achieve, and maintain compliance with applicable drinking water standards has been demonstrated."
>
> "Your system has been determined to have **adequate** technical, managerial, and financial capacity because:
> - Enter reasons here."

2.2.11 Outstanding Performance (1/12/11)

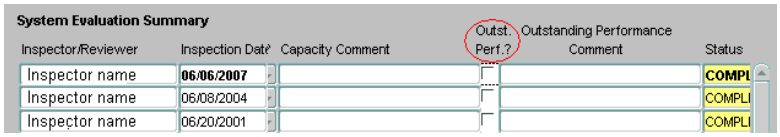
Community water systems are required by the SDWA to have sanitary surveys at least once every 3 years, however the Groundwater Rule allows for community systems to be on a five year schedule if they are determined to be outstanding performance systems.

To designate a water system as an outstanding performance system, regional DG staff must evaluate the technical, managerial, and financial aspects of the water system. Designation as an exceptional system requires concurrence by the Regional DG Supervisor. NR 809.35(2) includes very specific benchmarks that a system must meet in order to qualify as an outstanding performance system. These are:

1. No violations of MCLs since the last sanitary survey.
2. No violations of monitoring and reporting requirements since the last sanitary survey.
3. No violations of primary drinking water regulations during the past five years or similar time period.
4. No significant deficiencies shall have been identified in the current sanitary survey or the previous sanitary survey.
5. Existence of emergency preparedness measures and backup facilities.
6. Expert operation and management of the public water system, for example, skilled, certified personnel in adequate numbers, existence of quality O&M manuals that are used by the staff; adequate budget and revenues.
7. Effective cross-connection program developed and implemented.
8. Stable water source with no significant interruptions in supply.

If it is determined that a community system meets these requirements, inspectors should check the outstanding Performance box on the "System Evaluation Summary" table. A comment should also be entered specifying why the inspector feels the system met these

requirements.



Non-community systems do not benefit from this designation as they are already inspected on a five-year frequency.

2.2.12 Assessment Letter (1/12/11)

The sanitary survey assessment letter is a formal document that must be retained by the PWS for at least ten years, NR 809.82(3). It documents the infrastructure that exists at the system, what was inspected, what is working well, and what (if any) corrective actions need to be completed along with proposed compliance due dates. It serves as a state proposed Corrective Action Plan and Schedule. Systems must either agree to this schedule or propose an alternative one that inspectors concur with (NR 809.327)).

2.2.13(a) Write-up (2/23/11)

Before creating an Assessment letter, inspectors should make sure that the "Survey checklist for selected inspection," and the "Deficiencies for selected inspection" screens are completed (see sections 2.2.3(c) and 2.2.3(d) for more information). Information from these screens is used to populate tables in the assessment letter with the deficiencies noted during the inspection. See example below.

Deficiency	**Compliance Due Date**	**Code Citation**
1. All water loading stations are not provided with adequate backflow/backsiphonage protection.	1/1/10	NR 811.78(1)
2. The system has not sent a copy of their CCR and/or their Certification form to DNR by their due dates.	1/1/10	NR 809.837(3)
3. The number of dead-end mains are not minimized.	1/1/10	NR 811.70(8)

Sanitary Survey Assessment letters are obtained on the DWS by pressing the "Create assessment report for selected inspection" button on the sanitary survey screen

The deficiencies are automatically organized in the inserted tables according to severity. Significant deficiencies occur in the letter first followed by minor deficiencies and recommendations. They are also arranged according to the priority number assigned to them by the inspector on the "Deficiencies for selected inspection" screen. Following the tables, inspectors should include additional text describing the corrective action that must be completed.

The assessment letter obtained from the DWS will have minimal system summary information. The additional detail that should be added to the letter by inspectors is dependent on system type and the complexity of the system. It can be very

advantageous to insert annotated digital pictures in the assessment report. Pictures are a very good means of enhancing the description of the available infrastructure, as well as helping to focus on specific deficiencies.

TN Assessment letters

Assessment letters for TN systems are intended to be very brief and to the point. In addition to the default language automatically inserted into the letter by the DWS, inspectors should give a brief written description of what needs to be done to complete any corrective actions. Unlike the other system types, the TN assessment letter should not include a detailed summary of the system infrastructure. The pre-survey report includes the basic system summary data that is required for a complete assessment report, and must be attached to the assessment letter.

Assessment Letters for Community and NN Systems

In addition to deficiency and corrective action information, assessment letters for community and NN water systems should include a detailed summary of the infrastructure present at the system. Detailed information about the well or surface water source, storage, distribution system, treatment, and emergency power should be written out.

2.2.13(b) Review (1/12/11)

Regional supervisors should review assessment letters for all system types, except county contract TN's. DNR Reps have the responsibility to review assessment letters for the contracted counties they oversee.

Review should include verification that corrective action dates are followed up on, and that inspectors are moving non-compliers through the stepped enforcement process. In addition, those with the responsibility to review sanitary surveys should make sure they are being completed before the due date passes. The quarterly reports and monthly significant deficiency tickler are valuable tools for tracking this.

2.2.13(c) Mailing & Routing (2/23/11)

The original signed letter should be mailed to the system owner. A copy of the signed letter should be put in the regional file of record. A copy of community and NN assessment letters should also be mailed to the central office. At present hard copies should be sent to the central office, though in the future we might move toward allowing scanned PDFs to be emailed to central office.

2.2.14 File of Record (1/12/11)

The DNR Public Water System Program records retention schedule is detailed in the *Records Retention/Disposition Authorization.* The official physical file of record for all public water systems will be kept in the regional office. In addition to other documents, this file shall include all original sanitary survey documents, including:

- Signed Sanitary Survey Assessment Letters
- Signed Corrective Action Verification forms

- Correspondence

2.2.15 Follow-Up (Not Developed)

2.2.15(a) Tracking (Not Developed)

2.2.15(b) Verifying Compliance (Not Developed)

2.2.15(c) Enforcement (Not Developed)

2.2.16 County Contract Process (Not Fully Developed)

County Contract inspectors follow the process laid out in the guidance the department provides them.

1. County inspectors obtain pre-survey reports for systems with up-coming surveys using the County Sanitary Survey System. **(See directions on how to use the system in Appendix A.)**
2. County inspectors fill in the pre-survey reports during their surveys
3. County inspectors use the Electronic County Sanitary Survey System to create a sanitary survey letter.
   a. Letter must be sent to system owner within 30 days of the survey
   b. Letter must include a copy of the completed pre-survey report "checklist"
   c. Copy of the letter (with checklist) must also be sent to DNR Reps
4. The information from the survey is reviewed by the DNR Rep
   a. Checklist
   b. Deficiencies
   c. Dates - Inspection, letter sent, compliance due, compliance achieved
   d. New/missing system information – contacts, casing height, pump cap., etc.

2.2.17 Timeframes for Correcting Well Construction Problems (5/21/13)

When violations are discovered, the water supplier should be given a reasonable length of time to make the necessary corrections. Since there may be extenuating circumstances and seasonal considerations the following times are suggestions and judgment must be used in each case. In sanitary surveys of community water systems some of the findings may not be violations but rather recommendations and should not be given a time constraint. Examples are recommended engineering studies, second wells, additional storage, etc. When confirming violations in writing to the owner, the appropriate administrative code reference must be given. For violation resolutions not listed below, compare the violation to those given and determine an appropriate time.

2.2.17(a) Community Water Systems – NR 811

If unsafe conditions exist, the above time can be shortened, if feasible and reasonable

Violation Resolution	Suggested Timeline
Upgrade or replace un-grouted well	1 year

Install well vent, u-bend, or screen	1-2 months
Install sampling tap	1-2 months
Obtain and install standby emergency chlorinator	1 year
Purchase laboratory testing equipment	3 months
Adopt well abandonment or cross connection ordinances	1 year
Update overall plan of water distribution system	6 months to 1 year
Eliminate buried suction line	1 year
Clean and inspect buried reservoir	6 months
Eliminate or replace unsafe buried reservoir or well	Take out of service immediately,case-by-case use with chlorination for 1 year
Eliminate or replace potentially unsafe buried reservoir or well	1 year

Rational	
Major work requiring budget and contracts	at least 1 year
Purchases less than $1,000	at least 3 month
Minor work by waterworks personnel	at least 2 month
Ordinances to be adopted by municipality	at least 1 year

2.2.17(b) Non-Community Water Systems – NR 812

For inspections conducted during the winter months a compliance date of April 15 (after the frost is out of the ground) and at least the 2 or 3-month period should be given.

Violation Resolution	Suggested Timeline
Construct replacement well or relocate sewer meet separation requirements	3 months to
Construct replacement well or relocate septic to meet separation requirements	3 months tank
Construct replacement well or relocate absorption to meet separation requirements	3 months field
Upgrade pit-install drain or sump, curbing around manhole	2 months
Eliminate pit, extend well above grade	2 months
Eliminate buried suction line or buried well terminal	2 months
Replace or provide proper well cap	1 month
Install sampling tap	1 month

Install proper well seal	1 month
Install check-valve in proper location	1 month

2.3 Well Grouting Inspections (1/12/11)

2.3.1 General

Regional DG staff observe the grouting of new wells for community water systems to verify that the wells are grouted according to specifications. When a new well is approved, the water system owner is sent a letter which requests that the Regional DG staff person assigned to the water system be notified 48 hours before the grouting operation.

All Public Water Supply Section approvals contain a requirement that the water system owner provide a competent inspector during construction of the well, including the grouting operation. This inspector and/or the consulting engineer should be present at the grouting. The role of the Department representative at a grouting operation is to observe the procedures and to advise the water system owner's inspector/engineer when any deviations from the approved specifications are noted. If onsite modification of the grouting procedure is necessary the DNR representative should be involved in those discussions. The water system owner's inspector, not the DNR representative, is responsible for giving direct orders to the grouting contractor.

2.3.2 Inspection Procedures (1/12/11)

The following procedures should be followed:

- The plans and specifications and the approval letter should be reviewed prior to going to the well site. This gives the observer a familiarity with the approved procedures and provides an opportunity to ask questions of other Regional or Central Office staff.
- The well construction should be checked with the water system owner's inspector upon arrival at the site to determine if it conforms with the approved plans. This step is necessary before the grouting begins. The well location compared to the approved location should also be checked. If extra well casing pipe is onsite, the grade of pipe (ASTM A53, etc.) should be recorded on the inspection report.
- The amount of grout that will be necessary should be calculated using the table in 2.3.3. However, a larger amount of grout is often necessary due to crevices, cracks or openings in the geologic formations. As established in s. NR 812.20(2)(c), the grout shall be placed in one continuous operation, if possible. It is the well constructor's responsibility to ensure that all necessary materials are on the job site. Non-continuous grouting is required to be reported on the well construction report along with the justification or reason.
- The density of the grout being supplied to the site and the density of the grout as it flows out of the annular space between the casings upon completion of the grouting operation should be checked utilizing the table in 2.3.4.
- In accordance with s. NR 811.12(1)(d), the outer casing shall be removed during grouting unless it is grouted in place. The resident inspector should be reminded of this requirement prior to the grouting operation.

- The grout piping and methods should be reviewed prior to grouting. All methods should also include a back-up should the primary grouting method fail. **Plastic pipe may not be used as a grout pipe** (see s. NR 811.12 (14) (b) 8). The annular space must be at least 1.5 inches in order to allow for installation of an adequately sized grout pipe (NR 811.12(14)(b)(2).
- The Well Grouting Report, Form 3300-73 (2.4.6), should be filled out at the site and the copies should be sent to the Regional DG supervisor and the Public Water Supply Section.

2.3.3 Volume of Annular Space (1/12/11)

Volume of annulus cubic feet / linear foot

Inner Casing Diameter (Inches)	Diameter of Outer Casing (Inches)									
	10	12	14	16	18	20	22	24	26	28
8	.155	.391	.552							
10		.167	.327	.638	.993					
12			.071	.382	.736	1.13	1.57			
14				.199	.554	.952	1.39	1.88	2.41	
16					.227	.625	1.74	1.55	2.08	2.65
18						.254	.696	1.18	1.70	2.28
20							.28	.766	1.30	1.87
22								.308	.837	1.41
24									.336	.908

2.3.4 Grout Density (1/12/11)

Gal. H_20 Per Sack Cement	Weight lb/gal	Sp. Gravity	Volume Cu. Ft
5.0	15.80	1.89	1.15
5.5	15.39	1.84	1.22
6.0	15.02	1.80	1.28
6.5	14.69	1.76	1.35
7.0	14.39	1.73	1.42

One sack of cement = one cubic foot = 94 lb.
One sack of cement has an absolute volume of 0.48 cubic feet or 3.59 gallon

2.3.5 Calculating Required Volume of Grout (1/12/11)

Number of bags of cement needed to grout well =
Volume of annulus (in ft) / Volume of 1 sack (ft^3)(from Table in 2.4.3)

Example: Amount needed for 50' well w/10" inner casing and 14" outer casing using 6 gallons H_2O per sack cement.

No. of sacks needed = .327 (50) / 1.28 = 12.77 = 13

2.3.6 Well Grouting Report (1/12/11)

A copy of the well grouting report (Form 3300-073) can be found on the Eforms listing at http://intranet.dnr.state.wi.us/formscatalog/ffDispFormImage.aspx?FormID=18990

2.4 Pitless Unit Pressure Testing

2.4.1 General (1/12/11)

There may be occasions when Regional DG Staff are witnessing pressure testing of pitless adapters or pitless units. When a pitless adapter or pitless unit is installed on a school well or a noncommunity well that is also a high capacity well s. NR 812.31(2)(c) requires pressure testing of the unit and notification of the department. Pitless units may also be installed at community water systems under s. NR 811.35. The approval will require notification of Regional DG Staff so that staff may be present at the pressure testing. Regional DG Staff should attend all pressure testings of pitless units at community water systems.

2.4.2 Testing Requirements (1/12/11)

The pressure testing of pitless adapters or pitless units regardless of the type of water system must follow the requirements of s. NR 812.31(2)(c).

2.4.3 Documentation (1/12/11)

After witnessing the pressure test the Regional DG Staff person should document the contact by using a facility contact form. A copy of the form should be sent to the plan review engineer responsible for the approval of the facility. Information on the contact should include:

- Name of the Regional DG Staff
- Date of testing
- Firm conducting testing
- Facility name
- PWSID
- Approval number
- Statement of success or failure
- Description of unique features or events

2.5 New Facility Start-up Inspections

2.5.1 General (1/12/11)

Regional DG staff have the responsibility to insure that community water supply facilities are constructed according to the approved plans, the plan approval requirements, and ch. NR 811. Approved plans are required for new water systems and for any improvements, extensions or alterations which may affect the quality or quantity of the water delivered by existing systems (section 281.41, Wis. Stats. and ch. NR 108). This includes wells, pumphouses, chemical addition, water mains and storage and treatment facilities. It is also the Regional DG staff responsibility to insure that safe water is delivered upon a new facility startup (i.e., proper system disinfection, testing, etc.).

2.5.2 New Water Supply System Inspection (2/23/11)

2.5.2(a) Construction Oversight

The Regional DG staff should contact the water system owner and/or the consulting engineer periodically during the water system's construction to ascertain:

- The expected startup date. This date should be sent to the Central Office so that coordination of sample bottle distribution and bacteriological sample tracking can be synchronized with the startup.
- The progress being made in obtaining a certified operator. At the time of facility startup, a certified waterworks or water system operator of the proper grade or an operator-in-training must be working for the water system. See NR 114, subchapter I, for details of operator certification requirements.
- That the construction is in accordance with the approved plans, plan approval requirements and ch. NR 811. If possible, the Regional DG staff person should inspect the facility during construction at least once. A Facility Contact Form (Form 3400-51) should be filled out on each inspection.
- That the needed ordinances will be passed and in place before start-up (cross connection, well abandonment, wellhead protection, etc.).
- That the necessary plans be completed before start-up (emergency action, security response, and wellhead protection)
- That all private well owners have been notified of the well abandonment requirements and have replied to the water system owner with their intent to abandon their private well or continue use under the permit provisions of the well abandonment ordinance.

2.5.2(b) Inspections Prior to Start-up

Upon completion of the water system and before water is delivered to the public, a thorough inspection of the water system must be carried out by the Regional DG staff person (NR 810.26(1)(a)(1). This inspection should include:

- A review of the chemical/radiological sample results if not already done.
- An inspection of the water system to see that it was constructed according to the approved plans and plan approval requirements.
- A review of the procedures followed in the disinfection of the wells, mains, treatment and storage facilities and a review of the safe samples obtained. Safe samples should be obtained from numerous locations in new distribution systems.
- Providing the operator any O&M technical assistance needed, such as:
    - Completion of DNR reporting forms. ○ Sampling procedures and frequency. ○ Testing methods.
    - Nomographs for chemical feed calculated dosage rate.
    - Well water level reading procedure.
    - Setting up of cross connection control programs, main flushing programs, etc.

  NOTE: Many of these topics will be covered in the operator training courses and by the consulting engineer's startup assistance program.

- A review of the wellhead protection plan and ordinance.
- A review of the private wells to be abandoned or permitted once the system is in operation.
- A review of the monitoring schedule for lead and copper monitoring.
- A review of the bacteriological sampling plan and sample locations.
- A review of the disinfection byproducts sampling plan and sample locations.
- Verification that the capacity evaluation was completed (see section 5.2)

2.5.3 Inspection of Additions to Existing Water Systems (1/12/11)

2.5.3(a) Chemical Feed Start-up

Before chemical addition begins, the Regional DG staff should perform an inspection. The following items should be reviewed:

- The equipment set up as compared to the approved plans and plan approval recommendations.
- Compliance with ch. NR 811.
- The method for determining the daily calculated dosage.
- The sampling and testing procedure for the chemical being added.
- The correct method for completion of the monthly report.

2.5.3(b) Wells, Pump Houses, Water Mains, Treatment and Storage Facilities Start- up

These facilities do not have to be inspected before they are placed on line, however, it is the Regional DG staff responsibility to insure that all facilities are disinfected and tested bacteriologically safe before they are placed in service. The requirements for sampling, disinfection standards, and numbers of required samples are listed in s. NR 810.09(4). Copies of the standards should be kept in the regional offices for reference. During the next inspection of the waterworks (annual inspection or sanitary survey) following the construction of one or more of these facilities, these new facilities should be thoroughly inspected to see if they conform to the approved plans, plan approval requirements and ch. NR 811.

2.5.4 Start-up Approvals (1/12/11)

Prior to the start-up on any new community water system or improvements to any existing community water system a written approval shall be obtained from the department. The requirements for approval are found in s. NR 810.26(1). Correction of deficiencies is required for new systems prior to start up authorization, correction of deficiencies may be required prior to start up authorization for improvements to existing systems. The approvals are prepared by the Regional DG staff assigned to the specific water system. An inspection prior to issuing approval is always required for new water systems. Inspections of improvements to existing water systems are at the discretion of the Regional DG staff. It is recommended that any improvements that are related to treatment of acute contaminants such as bacteria or nitrates receive an inspection prior to approving start-up.

2.5.5 DWS Updates (Not fully developed)

Add appropriate treatment codes to the DWS under the source. Make the EP and/or source

active. The following day run a revised monitoring requirements report for the year, and send NEW monitoring forms to the operator-in-charge.

2.6 Reservoir Inspections

2.6.1 General (1/12/11)

It is the responsibility of Regional DG staff to ensure that reservoirs are routinely inspected as required by s. NR 810.14. This is typically incorporated into the annual inspection or sanitary survey. In addition Regional staff may be asked to comment on the acceptability of or precautions necessary for the various types of inspections.

2.6.2 Frequency (1/12/11)

S. NR 810.14(1) requires that all water storage facilities be inspected every 5 years. A drain down inspection is not required for each inspection. The Department does allow alternate types of inspection. These have become very attractive to utilities because tank down time is minimized or avoided. If a tank is thought to be in good condition, an alternate type of inspection may be appropriate. A full drain down inspection shall be conducted every 10 years or every other inspection.

If work is done on a tank that may impact the interior coating or may leave the tank susceptible to contamination, an interior inspection may be warranted. This could include the installation of telecommunication equipment, removal of cathodic protection systems, installation of railings etc. Welding on the outside of a tank can damage an interior coating.

The exterior of tanks should be routinely inspected twice per year by utility staff or their representative. This should include checking vent and overflow screens, assuring that hatches are closed and locked and checking general condition.

2.6.3 Reservoir Inspection Form (2/23/11)

The DNR form “Reservoir Inspection Report” (form 3300-248) must be completed for every inspection and submitted to the regional drinking water engineer. The form is available on the intranet E-forms but not the external internet. This is a requirement of NR 810.14(4).

2.6.4 Discharge of Chlorinated Water (1/12/11)

The requirements for the discharge of chlorinated water from a reservoir or from main flushing are covered under the General Permit to Discharge Under the Wisconsin Pollutant Discharge Elimination System (WPDES), specifically the permit on Hydrostatic Test Water or Water Supply System Water. The General Permit allows flushing of water with chlorine at normal system levels without any treatment. Discharge of water with chlorine levels above the normal system level requires some type of chlorine reduction treatment. This can include:

- Induced Dissipation – use of spray chamber, packed tower etc.
- Natural Dissipation – allowing the water to sit before being discharged or traveling overland for a sufficient time and distance
- Chemical Reduction – Several sulfur compounds are commonly fed for

dechlorination

The permit states that the chlorine level in all water discharged to any stream be less than the normal level in the distribution system. The goal is that all water discharged to any stream have a chlorine level less than 0.04 mg/L.

2.6.5 DG Staff Inspections (1/12/11)

These are inspections that DG staff may request. These are not inspections staff will do other than view from outside.

2.6.5(a) Confined Space Entry

No DNR employee is allowed to enter into a permit-required confined space without proper training as per the DNR Confined Space Handbook No. 9181.5. Any inspections of confined spaces are the responsibility of the water supplier. They need to utilize a qualified inspection team that is trained to enter confined spaces which in turn will issue a report to be submitted to the Department. Confined spaces inspectors may encounter include ground reservoirs, elevated tanks, buried pits, etc.

2.6.5(b) Climbing Elevated Tanks

Department policy states that staff not climb elevated tanks for routine inspections. If staff believe that close observation of a water tower is warranted, they should request that the owner of the tower have an inspection conducted and provide the requested information to the Department.

2.6.6 Inspection Methods (1/12/11)

2.6.6(a) Drain-Down Inspection

Drain-down inspections involve completely draining a tank. This type of inspection is required a minimum of every other inspection or every 10 years if other types of inspections are utilized. This type of inspection may also be dictated if it is thought that there are problems with the tank and repairs will be needed. After draining the tank, all sediment must be cleaned out prior to doing the inspection. NR 810.14(2).

The inspection may require the use of ladders and/or rigging inside the tank.

AWWA Standard D102-53 (R86), Standard for Inspecting and Repairing Steel Water Tanks, Standpipes, Reservoirs, and Elevated Tanks for Water Storage is old and somewhat dated but does contain some useful information. The AWWA Manual M42, Steel Water-Storage Tanks, also contains some useful information.

2.6.6(b) Peek-In Inspection

A peek-in inspection involves opening the access hatch and looking inside the reservoir without actually entering. This type of inspection may reveal major problems but is <u>not</u> sufficient for the required 5-year inspection. It is typically used as a follow-up inspection within a year of painting or when problems are not expected. A peek-in inspection is best

done with the water level in the tank taken down to about half full.

2.6.6(c) Float-Down Inspections NR 810.14(2)(b).

Float down inspections involve entering the tank with an inflatable raft. The raft must be thoroughly disinfected prior to entering the tank. The water level is usually lowered during the inspection to expose more of the tank area. A float-down inspection can be very effective for inspecting the inside of the tank above the water line. It is doubtful that the areas below the raft can be adequately inspected.

2.6.6(d) Diver Inspections NR 810.14(2)(c)

There is a section of AWWA Standard C652-02, which is the basis for the following list of requirements for underwater tank inspections in Wisconsin.

- Underwater inspections should only be conducted on reservoirs where repairs or significant maintenance are not expected.

- Although not mandatory, the tank should be isolated from the potable system during the inspection. The Department does not recommend on-line reservoir inspections although we know that many utilities will want to do them. Unanticipated demands on the water system during on-line inspections could pose serious dangers to the divers. Also, unplanned contamination to the reservoir by the inspection team could occur and pose a health threat to the customers. The tank should remain off-line for a minimum of 15 minutes after the last diver leaves the tank.

- A minimum free chlorine residual of 0.5 mg/l must be maintained in the tank throughout the entire inspection. Samples must be taken from the tank (not the sample tap on the riser pipe) before entering the tank and upon leaving the tank to assure the minimum chlorine residual level of 0.5 mg/l is maintained. If sediment is removed from the tank, chlorine residuals from the tank must be taken every four hours during the inspection.

- All divers must be certified commercial divers having passed an ACDE approved course or 1st or 2nd class US Navy Diver training or equal.

- All divers must be provided with commercial grade diving equipment.

- All divers must use totally encapsulated diving dress including dry suit and full face sealed mask with sealed neck dam.

- The diver's equipment must include voice communications with the surface and umbilical.

- The inspection team must consist of a minimum of three people including at least two certified commercial divers.

- All equipment introduced into the water must be dedicated for potable water use and must be disinfected with a minimum 200 ppm chlorine residual prior to entry.

- The dive team must provide still photographs or color video with live voice recording to monitor all activities, findings and actions.

- No underwater welding is allowed. Underwater coating repair is limited to use of products approved under NSF Standard 61 for underwater use.

- A minimum of two safe bacti samples be obtained from the tank after the inspection, one following the inspection and one 24 hours later. The tank may be in service during the 24-hour period, whether the tank has been isolated or not.

- All personnel on the dive team must be free of communicable diseases and shall not, without a physicians consent to return to diving activity, have been under a physician's care within the seven day period prior to entering the facility. No person who knowingly has an abnormal temperature or symptoms of illness shall work in a water storage facility. The water utility operator has the right to request a physician's assurance (based on an examination within the 48-hour period immediately prior to the time the diver enters the water storage facility) that all inspection personnel are free of water-transferable communicable diseases.

- The regional DNR engineer must be informed of the date of the inspection.

2.6.6(e) ROV Inspections NR 810.14(2)(d)

ROV inspections are common and provide additional safety and cost-saving benefits.

2.7 Well Site Surveys – Community Water Systems

2.7.1 General (1/12/11)

Well site surveys are generally conducted by Regional DG staff. The primary objective is to ensure selecting the best well location available for protecting the well from bacteriological and chemical contamination. Separation distances for a select number of potential contamination sources are listed in s. NR 811.12(5)(d). The Survey Report (Form 3300-74) is submitted to the Public Water Supply Section and should provide sufficient information to enable the plan review staff to evaluate any potential sanitary hazards with respect to the proposed well construction. In some cases, where the required separation distances cannot be obtained, rejection of the site or modifications in well construction may be necessary as determined by the plan review staff.

2.7.2 Frequency (1/12/11)

Regional DG staff should conduct well site surveys for all proposed wells for other than municipal (OTM) water systems. Most OTM water systems face significant challenges in meeting the separation distances listed in s. NR 811.12(5)(d). Conducting a site survey will ensure the owner and the well driller have considered all options and will assist the plan review staff with the approval process. For municipal water systems the Regional DG staff should consider the specifics of the water system and the challenges in siting the well. Where

conducting a survey can assist the community in identifying acceptable locations and assist the plan review staff in evaluating the acceptability of the site the Regional DG staff are encouraged to conduct a site survey as workload permits.

2.7.3 Well Site Survey Form (1/12/11)

The form can be found by searching for form number 3300-074 on the e-forms page http://intranet.dnr.state.wi.us/formscatalog/Default.aspx

2.7.4 Conducting the Well Site Survey (1/12/11)

Regional DG staff conducting site surveys will use the following guidelines. These guidelines are not all-inclusive and the condition at each site must be thoroughly investigated. Regional DG staff should be familiar with the separation distances listed in s. NR 811.12(5)(d).

- The consulting engineer or well driller should provide a map showing the location of the proposed well. If a map is not available, a detailed site description and location should be given in the site report written by the Regional DG staff DNR conducting the survey.
- A detailed description and/or location of the following should be given when applicable: buildings, topography and drainage at the site and surrounding area, sanitary and storm sewers, private and public wells, municipal and private sewage disposal system, refuse disposal sites, fuel storage facilities, marshy or low areas, lakes and streams, flood plain boundaries if known, test well sites, drillholes for mineral exploration, working or abandoned mines, quarries, rock outcroppings, and any other features that would be of significance. Photographs showing the proposed site and surrounding area from several views are desirable.

The above items are extremely important for shallow wells constructed in drift formations. The desirability of owning sufficient land at the site to control the surrounding environment should be stressed in discussions with officials. If the site is questionable, the owner or consulting engineer may request site approval from the Public Water Supply Section prior to submission of the final plans. Information concerning the proposed well construction should accompany the site approval request. If the site survey is for a well to serve a proposed water system, information should be obtained concerning any private wells which utilize the same aquifer as the proposed well. In some cases the Public Water Supply Section may request that samples be collected from one or more private wells in order to determine the chemical quality of the water.

2.8 RTCR Assessments (12/14/16)

2.8.1 General

Formal “Assessments” are required in response to Total coliform and *E. coli* contamination (NR 809.313). These are inspections specifically designed to identify and correct any “sanitary defects” that might allow microbiological contamination to enter the distribution system. There are two different levels of these assessments. Level 1 Assessments are only performed by community water systems. They are not as in depth as Level 2 assessments. Level 2 Assessments are performed by DNR &

County inspectors and require a more rigorous inspection of the system. Assessments **must be completed within 30 days after the system learns that it has exceeded atrigger** (NR 809.313(1)(b)1 and (c)1.

Level 1 assessment triggers.

1. For public water systems taking 40 or more samples per month, the public water system exceeds 5.0% total coliform-positive samples for the month.
2. For public water systems taking fewer than 40 samples per month, the public water system has two or more total coliform-positive samples in the same month.
3. The water supplier fails to take every required repeat sample after any single total coliform-positive sample.

Note: Non-community public water systems do not do Level 1 Assessments in Wisconsin

Level 2 assessment triggers.

1. An *E. coli* MCL violation, as specified in NR 809.30.
2. A second Level 1 trigger within a rolling 12-month period
3. For public water systems with approved annual monitoring, a Level 1 trigger in two consecutive years.

Note: Non-community water systems require a Level 2 Assessment for any Level 1 trigger in Wisconsin

A treatment technique violation occurs if a system fails to complete required corrective actions by the state approved deadline. **For more detail on treatment technique violations please see chapter 12.**

The protocol for **follow-up samples** after an assessment trigger occurs is discussed in **chapter 6**. Sampling to investigate the potential sources of contamination, for the purpose of developing a corrective action plan, is discussed in 2.8.5 below. *E. coli* MCLs and TTVs require systems on reduced monitoring to go on increased monthly monitoring frequencies. This is also discussed in **chapter 6.**

2.8.2 Federal Rule

The Federal Revised Total Coliform Rule (RTCR) was promulgated in the Code of Federal Regulations on February 13, 2013. It replaces the Total Coliform Rule (TCR), promulgated in 1989. The requirements for Level 1 and Level 2 Assessments are part of the RTCR.

2.8.3 Authority & Responsibilities

The requirements to conduct assessments are established in NR 809.313.

2.8.4 Scope

The minimum elements of an assessment include review and identification of inadequacies in sample sites; sampling protocol; sample processing; atypical events that could affect distributed water quality or indicate that distributed water quality was impaired; changes in distribution system maintenance and operation that could affect distributed water quality, including water storage; and source and treatment considerations that bear on distributed water quality. In general RTCR assessments are similar to sanitary surveys, however, RTCR assessments differ in that the focus is on identifying and correcting a known contamination event. Sanitary surveys are broader in scope, but assessments are more urgent in nature. The federal rules also use different terminology for the problems discovered during RTCR assessments than sanitary surveys. When performing RTCR assessments inspectors are looking for “sanitary defects.” These are substantially similar to significant deficiencies; however, sanitary defects only involve problems with “barriers to contamination.” Not all significant deficiencies are sanitary defects, but virtually all sanitary defects are significant deficiencies.

2.8.5 Investigative Sampling

In addition to the normal two sets of two clean investigative samples following chlorination, many RTCR Level 2 assessments require a more intensive investigation of the contamination source to inform the appropriate corrective action. This is especially necessary if no obvious sanitary defects are discovered that can correct the contamination issue and contamination persists even after batch chlorination. When well samples are required it is ideal to have a faucet at the well to eliminate any piping issues. Sampling options to consider are listed in the appendix to this section.

2.8.6 DWS Data Entry

Regional DG field staff are responsible for maintaining and updating the DWS records for assessments and any associated corrective action plan and schedule to address sanitary defects identified during an assessment.

2.8.7 Reviewing Level 1 Assessments – Community Water Systems

The Level 1 Assessment form is designed to be simple enough for most certified community public water system operators to complete using information they already have, with only limited guidance from DNR staff. Once the form is completed, DNR staff use professional judgment to determine whether or not the operator made a good faith effort in completing the assessment. Correction of any sanitary defects identified during the assessment is required either at the time of the assessment, or in accordance with an approved plan and schedule. It is not always possible, nor is it required, to identify a sanitary defect during a thorough level 1 assessment.

Note, a second level 1 assessment trigger incurred during the following twelve months requires a Level 2 Assessment performed by DNR staff.

2.8.8 Conducting Level 2 Assessments – Community Water Systems

Pre-Assessment Preparation

Prior to performing a Level 2 assessment, DNR field staff review sampling records, past sanitary surveys, well construction reports, and any other documents pertinent to their investigation. In addition, it is recommended that DNR field staff make note of any recent weather events that may have impacted the water supply.

On-Site Assessment

The on-site assessment includes an examination of water system facilities, operational procedures, sampling plans and practices, and relevant records. The assessment form provides a guide to ensure all aspects are addressed, including:

A. Public Water System and Consecutive System Owner Information
B. Assessment Agent Information
C. Recent Changes, Problems, and Pertinent Historical Issues
D. Monitoring Observations
E. Source Water (Groundwater) and Pump Observations
F. Treatment Observations
G. Surface Water Treatment Systems
H. Pressure Vessel and Booster Pumps/Station
I. Water Storage Facility
J. Distribution
K. Summarize Sanitary Defects and Unsatisfactory Observations
L. Explain any Corrective Actions
M. Proposed Corrective Actions Plan and Schedule
N. Completeness Checklist
O. Assessment Agent and Owner Signatures
P. WDNR Review and Summary

Assessment Documentation

DNR field staff are responsible for completing the Community Water System Level 2 Assessment form and distributing copies to the system representative and DNR file. The system representative, on site when the assessment was conducted, should be noted on the form. Depending on the complexity of the corrective actions noted it may be necessary to write a formal letter describing corrective action steps and deadlines. Completing the form and providing a copy to the system representative is acceptable for assessments where only coliform is found and the system has not had an assessment in the previous 12-month time period. A letter with additional information on the corrective action response is required for repeat confirmed coliform events within a 12-month time period, an *E.coli*. MCL, or illness outbreak investigation.

Each section of the form should have a checked response denoting whether elements within that section were identified during the assessment as a potential source of the coliform contamination event. If a section is marked “yes,” then mark all items in that section that apply.
Additional documentation including, pictures, guidance on corrective action options, and/or a letter may be included with any assessment. Inspectors are encouraged to provide any additional resources or letter to provide additional directions they feel are needed. The additional materials will provide the system with directions on current corrective actions required, options for correction, and what additional actions may be triggered if the coliform contamination event is not resolved.

Corrective action due dates may be assigned by the Inspector for potential sanitary defects in consultation with the system representative. Note: Systems with an *E. coli* MCL will remain on boil water until the corrective actions are complete.

2.8.8(a) Public Water System and Consecutive System Owner Information

Provide the system name, PWSID number and contact phone number.

2.8.8(b) Assessment Agent Information

In all cases, DNR field staff perform the Level 2 Assessments. DNR field staff work closely with the operator in charge of the public water system, but the responsibility for ensuring the integrity of the assessment lies with the DNR field staff who perform the assessment.

2.8.8(c) Summarize Sanitary Defects and Unsatisfactory Observations

Any sanitary defect discovered during the assessment must be explained in enough detail that the person responsible for correcting it understands the issue. It is likely that pictures and additional supporting documentation will be needed, especially if the issue is at all complicated. Minor things may just be described in the space proved in Section K.

2.8.8(d) Explain any Corrective Actions

Any sanitary defect discovered during the assessment must have a corrective action. This is a description of what will correct the sanitary defect. However, make sure corrective actions are not something we are prescribing when it is more appropriate for a consultant to advise the correct approach. Professional judgment will often be required. If there is any doubt, please consult with your supervisor. Minor corrections can just be described on the form. More complicated corrections will require additional supporting documentation.

2.8.8(e) Proposed Corrective Actions Plan and Schedule

Corrective actions identified in section L of the assessment form must have a formal corrective action plan and schedule, and must be discussed with the system and agreed to by both parties. This is very similar to corrective action plans for significant deficiencies. This corrective action plan and schedule must be tracked in the DWS PWS Actions screen. Any RTCR corrective action not complete by the agreed upon due date will create a TTV.

If the system needs to seek advice from a consultant before a corrective action plan can be agreed to, you can propose dates for fixing the problem, and later update the DWS actions table with information about what the actual corrective action was. During this process you can also extend due dates as necessary as long as due dates have not passed. DNR field staff are responsible for maintaining regular communication with the system during this corrective action process.

2.8.8(f) Completeness Checklist

This section is self-explanatory.

2.8.8(g) Assessment Agent and Owner Signatures

This section is self-explanatory.

2.8.8(h) WDNR Review and Summary

This section is where you summarize your findings. What was the likely cause of the event? Did the corrective action have the desired effect? Was the work satisfactory with all sanitary defects eliminated?

2.8.9 Conducting Level 2 Assessments – Non-Community Water Systems

<u>Pre-Assessment Preparation</u>
Prior to performing a Level 2 assessment, bacteria and nitrate sampling records pertaining to the public water system should be reviewed by the inspector. A sampling history report may be printed from the DWS. Reviewing recent weather events, that may have impacted the water supply, may also be useful. Inspectors should also review past surveys, well construction reports, and any other documents pertinent to their investigation.

<u>On-Site Assessment</u>
The assessment should include an onsite examination of all water system facilities, review of operational procedures, sampling plans, and records. An assessment must include the completion of a non-community Level 2 Assessment form. This form includes four sections.

A. Event Background Information
B. Survey of Five Water System Elements (Source, Pumps, Storage, Treatment, Distribution)
C. Description of the Event
D. Description for Corrective Actions

Corrective action due dates may be assigned by the inspector for potential sanitary defects in consultation with the system representative. In the rare situations when considering a corrective action for sanitary defects with a due date greater than one year the County Contract (CC) inspector, DNR field specialist, and the DNR field supervisor must consult each other before issuing an agreed upon corrective action and due date. Note: Systems with an *E. coli* MCL will remain on boil water until the corrective actions are complete.

Assessment Documentation

The non-community Level 2 Assessment form must be filled out by DNR or County staff and presented to the system representative. The system representative, on site when the assessment was conducted, should be noted on the form. It is desirable to have the owner present for the assessment but if the owner is not available the owner should be contacted and provided with a copy of the report. Depending on the complexity of the corrective actions noted it may be necessary to write a formal letter describing corrective action steps and deadlines. Completing the form and providing a copy to the owner is acceptable for assessments where only coliform is found and the system has not had an assessment in the previous 12-month time period. A letter with additional information on the corrective action response is required for repeat confirmed coliform events within a 12- month time period, an *E.coli*. MCL, or illness outbreak investigation.

Each section of the form should have a checked response denoting whether elements within that section were identified during the assessment as a potential source of the coliform contamination event. If a section is marked “yes,” then mark all items in that section that apply.

Additional documentation including, pictures, guidance on corrective action options, and/or a letter may be included with any assessment. Inspectors are encouraged to provide any additional resources or letter to provide additional directions they feel are needed. The additional materials will provide the system owner with directions on current corrective actions required, options for correction, and what additional actions may be triggered if the coliform contamination event is not resolved.

Corrective action due dates may be assigned by the inspector for potential sanitary defects in consultation with the system representative. County Contract (CC) inspectors should consult with their DNR field specialist and DNR inspectors should

consult their supervisor before issuing any corrective action due dates for sanitary defects greater than one year. This should almost never happen. Note: Systems with an *E. coli* MCL will remain on boil water until the corrective actions are complete.

2.8.9(a) Description of Event

In this section, describe any sanitary defects discovered during the assessment in greater detail. This may include multiple defects from multiple elements of the assessment. Depending upon the complexity of the issue, it may be necessary to include additional documentation to the report.

2.8.9(b) Corrective Actions

In this section, describe in greater detail the corrective actions needed to resolve the sanitary defects identified in the “Description of Event” section. In most instances, the appropriate corrective action will follow logically from the sanitary defect identified, i.e. if they have a rusted-out bacteria-laden pressure tank, the corrective action will be a new tank. However, make sure corrective actions are not something we are prescribing when it is more appropriate for a consultant to advise the correct approach. Professional judgment will often be required. If there is any doubt, please consult with your supervisor.

When the well is the issue, inspectors should present all the evidence of this, however drilling a new well may not correct the problem if the aquifer is contaminated. A consultant should make this determination, not the DNR. Though NR 812.26 allows for the DNR to require contaminated wells to be filled and sealed after three unsuccessful attempts at batch chlorination, this may not be advisable if a new well will not correct the problem. The system, in consultation with a consultant, should follow the approach discussed in NR 812.37(2)(e). Treatment is only allowed to correct bacteriologically contaminated wells if drilling a new well, or connecting to another safe source is not available.

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Additional RTCR Assessment Training

This appendix is intended to provide additional information that may be useful when conducting Level 2 Assessments. It does not include required procedures or policy. It is a reference for staff to consult when thinking through potential problems and solutions to common issues that may be contributing to bacterial contamination at public water systems.

INVESTIGATIVE SAMPLING

In addition to the normal two sets of two clean investigative samples following chlorination, many RTCR Level 2 assessments require a more intensive investigation of the contamination source to inform the appropriate corrective action. This is especially necessary if no obvious sanitary defects are discovered that can correct the contamination issue and contamination persists even after batch chlorination. When well samples are required it is ideal to have a faucet at the well to eliminate any piping issues. Sampling options to consider are listed below.

Adenosine triphosphate (ATP) - ATP is an estimate of the total microbial community present in a sample. It is used to determine if biological activity is predominantly in the well casing, or if it is coming from the aquifer. Testing is conducted on a first flush sample and a sample collected after sustained pumping (at least two minutes at maximum flow). Higher levels in the first flush sample when compared to the sustained pumping sample may indicate that in-well biofilms are an issue. The opposite result may indicate that aquifer contamination is a potential issue.

Most Probable Number (MPN) for coliform and *E.coli* – Coliform bacteria count data is useful to verify the effectiveness of a treatment process and risk assessment in drinking water when *E. coli* is not present. The following categories are based on information collected from a study of private well samples submitted to the State Lab of Hygiene.

- low level contamination < 25 coliform colony forming units (CFU) / 100 mL – over 60% of coliform positive samples were in this category
- medium contamination 25 – 100 coliform colony forming units / 100 mL
- higher contamination > 100 coliform colony forming units / 100 mL - 23% of coliform positive samples were in this category

The presence of any *E.coli* is a significant concern for the health risk of water consumers. Immediate investigative action is required if *E. coli* is detected in drinking water. Groundwater Rule corrective actions are required for *E.coli* confirmed in the source water of public water systems.

- Highest risk: any *E. coli*

Spaced Interval Sampling – This process is similar to the ATP sampling procedure discussed above.

1. Allow well to sit overnight and collect a first draw sample in the morning before building water use resumes.
2. Allow enough water to flush the drop pipe and let the pump kick in.
3. Allow water in well column (and pressure tank) to flush out to collect a sample representative of the aquifer. (see Design Water brochure for specific calculations)

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If counts are higher in the first flush sample, there may be a physical problem with the well or a biofilm. Options for further work include:

- Televise the well
- Dig up and inspecting casing, pitless adapter, and distribution piping
- Check buried piping

Indications that biofilm causing bacteria may be present include:

- The first sample is significantly higher in MPN
- The color of the water is darker in the first sample and much lower/absent in the second
- The odor is stronger in the initial sample and absent/much lower in the second

Note: Speciation of coliform to determine whether biofilm forming bacteria are present in combination with spaced interval sampling helps determine whether a biofilm exists and guide follow up rehabilitation of the water system.

Spatial Sampling - This process is useful in narrowing down the location of contamination to better address potential distribution system biofilms, cross connections, or well contamination. The number and location of samples collected depends on the system, but generally well samples and sample locations associated with treatment, or pressure and storage tank locations are useful. Additionally, any locations with recent detects should be part of the investigation.

Bacteria Identification - If total coliform bacteria are persistently present, inspectors may want to request MPN counts and speciation. When results are available; review the bacteria type to determine if it is associated with biofilms. Bacteria that produce a biofilm encapsulate and produce a slime layer that is resistant to chlorine, so they can rapidly multiply and cause unsafes after chlorination. If samples are all the same bacteria type or relatively few species are present in repeat results, this suggests a biofilm may be present. Review the counts and identification at different locations in the system to identify problem locations. If the identification shows different bacteria at various sites, then the bacteria may be entering at various sites in the distribution system.

Heterotrophic Plate Count (HPC) – This is another tool useful in detecting biofilms. Sample at spaced intervals to obtain samples representative of the well and aquifer. Standard HPC protocol has an 8 hour time limit to analyze for compliance but for information purposes the procedures allow up to 24 hours. Note on SLOH lab slip to run sample if older than 24 hours. Use of the R2A agar helps to obtain higher survival counts because of the richer media. Use of ice during shipping also enhances survival counts. A biofilm is suspected if:

- Standard HPC = > 200 cfu /mL
- HPC with R2A agar = > 500 cfu/mL

(reference from Design Water up to 60 cfu/mL in wells from soil organisms so aquifer samples should be 60 or less). Multiple colors of bacteria on the plate suggest a large diverse group of bacteria in the water system.

Large volume sampling - The 100 L large volume Hollow Fiber Ultrafiltration (HFUF) sample is perhaps our most sensitive and thorough fecal source tracking investigative tool. In general, it is appropriate to collect a HFUF sample if *E. coli* is present, or a recurring total coliform problem persists. This type of sampling concentrates microbial contaminants and allows for very low detection levels. It is a time consuming process and requires special training or consultation with another inspector already trained to collect and filter this type of sample. This sampling approach is particularly helpful in determining if microbial contamination is coming

from a human or animal source. This approach is generally used in concert with ATP analysis, MPN, bacteria identification and, where appropriate, microbial DNA analysis.

Microbial DNA Analysis - In some instances an aliquot of HFUF filtrate can be analyzed for the relative percentages of DNA present for a large suite of microbial organisms. This approach casts a very large net. It does not give an actual concentration of any organism, but gives the percentage of that organism's DNA as part of the whole. This is useful in determining the most prominent microbiological contaminant present. This method can also be used to identify the presence of disease causing organisms such as salmonella at very low levels.

CHLORINATION OPTIONS

When corrective actions have been completed and suspected sources of contamination have been eliminated, it will usually be necessary to eliminate bacteria present in the system through various chlorination procedures. If there is a persistent biofilm contamination event more intensive regimes may be needed.

Type of Chlorine:

a. Sodium hypochlorite without additives (regular liquid bleach 5-6%, liquid pool chlorine 10-12% - use NSF products)
   - Best in hard water
   - Products lose chlorine over time, Higher concentration products deteriorate faster
   - Presence of metals may increase deterioration

b. Calcium hypochlorite (solid granules or tablets)
   - Slow dissolving in cold slow moving water
   - Chemical reaction may yield scale development
   - May cause corrosion at pitless
   - May be used in combination with liquid chlorine to provide a residual at the bottom of the well

Dose of Chlorine: More is not always better and may decrease the available amount of hypochlorous acid to disinfect the water system. Some geologic settings are more sensitive to oxidative impacts of chlorine and special precautions may be necessary in these areas (Arsenic Sensitive Areas DNR PUB DG 069).

Shock/Batch Chlorination - A pump installer or well driller may mix up a batch of chlorinated solution to displace the water in the well and obtain contact with the casing and open bore hole. This is different from a simple chlorination which may only mix the chlorinated solution down to the pump when the water is recirculated through a hose.

Acid Chlorination - A pump installer or well driller may use a WI DNR approved well rehabilitation product or combination of salt and approved acid to treat a well for biofilm. Acid control of the pH helps to maintain the range where hypochlorous acid, the active disinfectant form of chlorine, is the dominant form present in the water. The salt and other compounds in approved products are designed to help treat biofilm. This procedure is best done by a professional since misuse of the product may release chlorine gas and is a safety concern. Due to the debris freed as part of biofilm treatment or if salt is used it is beneficial to have a contractor with a pump pulling device on site in case it is needed to clean the pump screen.

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Pulsed Dosing – persistent bacteria may evade initial chlorination attempt even with acid. Extending the dosing period does not allow bacteria to regrow in an active biofilm. The longer the time chlorine sits in a well the lower the recommended concentration of chlorine is lower to minimize corrosion of metal. Some chlorination products also control pH which is also beneficial to the process. This process is not recommended in some geologic settings due to damage oxidation may do to the aquifer (see Well Chlorination in Arsenic Sensitive Areas).

Possible Enhancements to chlorination:

- Flush pressure tanks, hot water tank, treatment systems, and lastly piping prior to chlorination to remove debris. As part of this process clean aerators at outlets.
- Brush casing and/or piping if suspect biofilm to physically dislodge slime.
- Use salt/acid or other approved treatment to remove biofilm.
- Raise temperature on hot water heater to high or 160° F may enhance disinfection (notify users to avoid scalding water when hot water is elevated for treatment).
- Ensure chlorine is drawn into tanks and piping. Test for chlorine at the furthest ends of the water system.
- Maintain adequate contact time - ex 8 hours. Follow product directions if using an approved product.
- Treat treatment equipment per treatment company's directions.
- Physical removal of debris from bottom of the well with air lifting vacuum.

COMMUNITY LEVEL 2 ASSESSMENTS

Recent Changes, Problems, and Pertinent Historical Issues

This portion of the assessment addresses the fundamental aspects of water system operations, including consumer and personnel issues or concerns, outside events that affect the system, and changes or problems with the water system itself.

Consumer and Personnel Issues or Concerns

These elements of the assessment form address whether or not a disease outbreak or illness has been documented, and whether water quality complaints have been received. In addition, these serve to document water system personnel changes, operator certification status, and whether the operator in charge is designated and is fulfilling supervisory responsibilities. Some of this information is available off-site, but verification while on-site is recommended.

Outside Events

The next set of topics addressed by the assessment form address outside events. Such events are typically outside the control of water system personnel, yet may have had a negative impact on water quality. They can include rain, flooding, lightning, fire, wind, or some other natural event. They may also include vandalism, intentional sabotage, or terror related. They may have occurred yesterday or several months ago. They may be cyclical, continuous, or a single event. Heavy precipitation may not only cause flooding of equipment but short circuit the filtering capacity of the aquifer. High wind may blow reservoir vents or protective coverings off the structure and leave unprotected openings. Fires and flushing may affect system hydraulics. Did the system lose pressure, stir things up before sample collection, or exceed treatment design throughput? Customer or industry

use may have put additional stress on the water system that it was not designed to handle and it may go un-noticed. Water main construction may have affected the sanitary quality of the water especially if heavy equipment was used near monitoring sites.

Water System Changes or Problems

The assessment form includes a set of questions addressing problems with the water system itself, such as water system design, equipment used, and its operation. Have there been any changes to pumps, distribution system components, treatment system equipment or its design? Were any changes made to how these units are being operated and are they operated within design requirements?

This section asks broad questions that will give you context, better understanding, and provide direction for further focus in the evaluation.

Monitoring Observations

This section of the assessment form provides a step by step process for evaluation of a system's monitoring practices. There are four areas of focus in this section: monitoring program in general, monitoring site where positive test results occurred, sample collection technique, and testing.

Bacteriological Monitoring Program

Water samples are required to be collected in accordance with a DNR approved monitoring site plan. It is the responsibility of the DNR field staff to review the monitoring site plan and sampling practices during each sanitary survey. Sampling sites should be representative of water throughout the distribution system and at geographically representative locations. Questions included in the assessment form address whether the plan is followed, whether geographic and water use patterns are represented, site rotation frequency, and schedule to minimize the non-monitoring window.

Bacteriological Monitoring Site (where the positive test result(s) occurred)

Considerations addressed in this portion of the assessment form include service line materials and condition, sample tap location and distance from service entrance, plumbing and cross-connection, sample tap type, and the general sanitary condition at the sample site(s).

The best sample tap is a single, smooth bore tap that is directly connected to the water main without any service line. The older and warmer the water in the plumbing, the more likely you will have biofilm no matter what your system chlorine levels are. Also, the more surfaces that are scraped (mixing valves/swivel faucets) the more likely you will dislodge a bacteria colony during sample collection. Excluding dedicated monitoring stations, the best location for a tap is in a building having good water use and located at the service entrance. Water age and temperature changes are minimized. Also, it should be near a drain. Bucketing water out will lead to short flushing times before sample collection.

Sample Collection

This portion of the assessment form includes considerations related to sample collection, including bottle age, storage, condition, flushing, preservation and shipping, laboratory certification, test method, QA/QC. If

possible consult with the sampler and/or water system operator to conduct a detailed review of their sampling procedures. Make note of any deviations or items of concern on the assessment form.

Bacteriological monitoring forms come with instructions on how to collect the sample. Proper technique is to run the water until the temperature gets colder, shut it off, flame the tap, and then run the water for 5 minutes before collecting the sample. Some operators skip the first part and jump right into flaming. This is not a good practice. Also, some operators will use chlorine to disinfect the tap rather than flaming it. This may be appropriate for a tap that you cannot flame (i.e. plastic fixture); however, chlorine is a disinfectant not a sterilizing agent. The best approach would be to only use metal taps that can be sterilized with heat.

Testing

The assessment includes review of laboratory certification, test method, QA/QC, sample holding time. In addition, for systems that chlorinate, the assessment includes review of the chlorine testing conducted in conjunction with collection of the bacti sample. This includes the chlorine test method, colorimeter and vial condition, reagent expiration date, colorimeter technique (read within 1 minute of reagent addition), and check standards run dates and results. As part of an assessment, verify that the chlorine test is conducted at the time and location that the bacti sample is collected. In addition verify that the chlorine test results are documented correctly as either free chlorine, total chlorine, or combined chlorine. For assessments at community systems that chlorinate, verify that the required check standards are run on a weekly basis.

Source Water (Groundwater) and Pump Observations

Groundwater Source and Well Construction

Obtaining a quality source water for drinking water purposes, and maintaining that quality when moving it above ground, depends on outside influences and land use activities in the vicinity of the well, geological and hydrology features of the aquifer the well is drilled into, well construction features, operational parameters of the well, and well maintenance. This section of the assessment covers these factors.

Geological and Hydrological Conditions

When assessing the geologic and hydrological features that could influence quality of a groundwater source, it is important to understand the regional and local geologic formations where the well is constructed. USGS and WGNHS may have publications with this information. They may also have an unpublished understanding of local or regional fractures, water quality issues and karst type features in the formation(s) of concern for a well.

Additional information may be available in the well site investigation report, engineering report, well drillers log book, well construction report, well head protection plan, and WGNHS may have evaluated the cuttings and documented their observations and/or assessment of the cuttings.

Community wells constructed since 1992 were required to complete a well head protection plan. Many of these plans contain modeling results that provide information on well yield, direction of groundwater flow, time of travel information, and outside influences on the well or source water.

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If there are other wells in the area, the investigation may include evaluation of the above information on those wells. This includes other municipal wells, high capacity non-municipal wells, private residential wells, and remediation and groundwater monitoring wells. It may be important to note where these other wells are in relation to the well under investigation because they could influence groundwater flow direction, water table elevation, and water quality. To complete this portion of the assessment, it may be helpful to consult with other professionals with more specialized skills. This includes a hydrogeologist, geochemist, licensed well driller, microbiologist and/or environmental engineer.

Separation Distance to Potential Contamination Sources

The assessment of separation distances includes the well construction code lists minimum setback distances to potential contaminant sources, In addition, it is suggested that the assessment include the potential contaminant and setback lists in ch. NR 812 and the contaminant use inventory forms.

While completing the on-site portion of the assessment, conduct a survey around the well. Take note of man-made features that could influence groundwater quality. Some of these features may have been permitted by other agencies with conditions intended to prevent release of potential contaminants or to control them at the site in question. Make note of any spills, leaks, or other noticeable releases and immediately bring them to the attention of system personnel to ensure timely corrective action. Further inquiry should be made to determine if there is reasonable potential of contamination reaching the groundwater source.

Natural features (streams, lakes, flooding, etc.) may also influence source water quality. If this is suspected, include the observation on the assessment form, to be addressed through follow up analysis or action as appropriate.

Well Construction and Sanitary Seal

Review available information on well construction prior to the on-site assessment, including the well construction report and any field notes by the DNR field staff who witnessed the drilling, grouting, and pitless adaptor pressure test. Relevant information may also include pump test records, pumping rate, well yield and drawdown.

The following list of questions may be helpful when assessing well construction as part of a Level 2 assessment, however, this level of detail may not be appropriate in every instance:

1. What are the formations encountered from surface to the bottom of the borehole?
2. Are there local or regional fractures, karst material, or gravel and what depths were they found?
3. What is the depth of the well casing and is it at an adequate depth to ensure good filtering capacity of organic solids, particulates, and biological contaminants?
4. Which formation is the well pumping from and is it hydraulically connected to nearby water bodies, wells, drain fields, storm water ponds, or other features of concern?
5. Is water quality maintained throughout the pumping cycle and extended pumping cycle?
6. Does drawdown drop below the casing?
7. Is the safe well-yield ever exceeded so that sand, soil (mud), or air is pumped into the water system?
8. What is the condition of the well screen, if the well has one?

9. Has the well been televised recently and what is it showing?
10. Does the well discharge colored water at any time during the pumping cycle?
11. Does the water turn color after exposure to air?

During the on-site portion of the Level 2 assessment, examine the well house, pitless adaptor housing/cover, and appurtenances to assure sanitary conditions.

Proper well construction includes grouting of well casing to the geologic formations for the entire length of the casing so as to prevent short circuiting of the filtering capacity of the formation(s). Water must not be allowed to bypass the soil and rock formations because unfiltered water is likely to be unsanitary. As such, an assessment must be made as to whether the casing was properly grouted.

The annular space, between the drill hole and casing, is filled with grout to fill up all voids or air spaces. With few exceptions, the grouting process should be done in one continuous operation and have the proper weight or grout density. This prevents shrinkage and cracking that could allow water to migrate through the cured grout. Department and well drilling records should be consulted to confirm whether the well was properly grouted. DNR staff are required to observe well grouting and complete a grout report. If the reports are not in the legal file, they may have been microfiche or digitized by the Bureau. The well owner or driller may also have records as well.

Pitless adaptors pose another possible entry point of water of poor quality. These units must be properly welded to the casing and pass pressure testing. DNR is required to observe this pressure testing and should document observations. Spraying soapy water on the weld joint, the grout-to-casing interface, and the threaded fittings of the pitless unit itself during pressure testing will provide valuable information on whether there are leaks and their locations. Leaks have been known to occur in all these locations, which can become entry points for contaminated water.

Before leaving the subject of construction, it is important to note that a properly constructed well does not mean that the integrity of the grout seal should not be questioned. The Department has found in some cases that the grout can be damaged when the starter casing is removed, during installation of the pitless adaptor because part of the grout must be removed, or by heavy vibrations near the well caused by blasting or heavy construction equipment. There have also been instances where a casing that terminates near a bedding plane or fracture with active flow had the grout washed out by this flow during the grouting process.

<u>Well Casing and Integrity of Penetration Points (vents/electric/airline)</u>

Well casing should be evaluated to ensure it meets regulatory specifications. This includes the type of material and its thickness. DNR staff, contractor, or project engineer should have documented this information during construction. Sections of casing must also be properly welded. There have been cases of poor weld and grout jobs, welds broken during the casing installation process, or corrosion at weld joints during operation of the well that allowed contaminated water to enter a well. If casing problems are suspected, the pump should be removed and the casing televised. Televising should be done before and after brushing to allow one to see water staining from a casing leak and holes in the casing or weld seams. Both indicate failure. Another test, which is more involved, is to have the casing packer tested to determining if it holds air. It should be pointed out here that whenever the pump's drop-pipe or column pipe develops holes (due to corrosion or poor fitting seal), the

casing should be televised. High velocity water flows through these holes and can cut a hole into the casing and through the grout. Also, if the column pipe is severely corroded and contains holes, the casing could also be severely corroded and compromised.

The well casing must terminate in a properly constructed pump base as shown in the state well construction code. There are several design requirements depending on number of casings used and whether it's a submersible or line shaft pump. In addition, equipment that runs into the well (well vent, air-line, and electrical wiring) must enter the well at least 4" above the wellhouse floor and must be sealed properly where it enters the casing to prevent foreign objects, including water or condensation, from entering the well. Venting must have the proper screen as well.

Building, Well House, or Pitless Adaptor Housing/Cover

Proper well construction is not the only safeguard for preventing well contamination. Proper design of other equipment above ground plays a role as well. Rainwater around the well and on the well house must have positive drainage away from the well. Pitless adaptor covers must do the same. Note any concerns and document them on the assessment form.

Drains (storm and sewer) and Site Drainage

The assessment form includes review of well house drains and sewer lines. Review their location and where they discharge. It is important that pipe integrity be maintained to the discharge point and the discharge point is appropriate. French drains are prohibited and buried lines need to be deep enough to prevent freeze damage. Dye testing may need to be carried out to determine where the discharge goes and it may be necessary to televise lines to ensure pipe failure has not occurred.

Source Water Quality

Review source water quality as part of the assessment. Review raw water sample history and sample collection practices. Consider additional investigative sampling and laboratory analyses as described in section 2.8.5 above. Raw water is tested quarterly to evaluate the sanitary condition of the source water. When bacteria is identified in the water, further testing may need to be made to evaluate potential causes. One should evaluate bacteriological monitoring history at each source water to determine whether there were problems in the past. Events may be cyclical, seasonal, or have some other failure frequency that may be determinative of what is occurring. Regardless of previous test results, one should first evaluate how sampling is being carried out and who is performing the tests. When are samples collected (days, times, and at what point in the pump cycle are they collected)? What is the sample collection protocol? Who is collecting the samples? Is the sample tap connected directly to the water main in front of other equipment or it the line connected to other, ancillary equipment, that could be the source of biofilm dislodged during sampling or running of the well pump.

When results are positive, the Wisconsin State Laboratory of Hygiene is able to speciate a water sample to determine type of micro-organisms present. You must request this at the time of sample submission and its best to contact the lab to ensure they are able to complete testing in the time frame you require. Results may offer clues as to the cause or source of contamination.

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Are there other water quality issues taking place that could affect the water sanitary condition (pumping air or mud)?

Well Televising/Inspection Results

Water that fails biological testing, exhibits other water quality related problems, or has quantity related problems (dropping yield or different drawdown) requires further assessment at the source. The well pump may be pulled and the well televised. Problems with the pumping equipment, well, screen, or formation can be gleaned from televising footage. A pump test may also offer clues to problems. Previous inspection results for the water system and past televised videos or information may be useful.

Well Maintenance Practices and Treatment Frequency

The Department recommends that all well pumps be pulled and inspected every 10 years. Some well contractors televise a well after the pump is pulled, perform a pump test before and after work, and provide a report of findings. This may provide documentation on historical issues or issues that may not have been addressed when the pump was pulled. This includes depth of the casing, formation, and whether the bore-hole or some of the bore-hole has filled in with sediment. It also may include undocumented or unapproved casing or well work in the past. For instance, a grouted liner casing may have been installed or the hole may have been filled to seal a lower formation of poor quality. Either of these could affect draw-down, well yield, or water quality.

Regardless of whether televising was done during pump maintenance, the well contractor needs to convey important information to the owner. This includes the type of pump pulled and installed, the pumps setting, length of air-line, and pumping rate. Any change of pumping capacity or pump setting must be approved. It is also a good practice to inspect the casing and pump base when the pump is pulled to ensure it meets design requirements for the type of pump and casing that is used.

Some wells are prone to plugging and it may be the result of mineralization, biological, or both. The screen may be plugged or failed. Some questions for consideration during an assessment include:

1. Has a proper pump test been performed recently?
2. Has the well been rehabilitated in the past? (chemical, hydraulic, mechanical, or other)
3. What does the televising footage show?
4. If a well is routinely being treated, has treatment changed or is it still effective?
5. Is there biofilm in the well causing loss of capacity or corrosion?

Televising should also be completed after rehabilitation to ensure none of the components (screen, casing, borehole) were damaged during the process.

Well Pump and Appurtenances

When evaluating the pump and appurtenances as part of a Level 2 assessment, consider the following list of items.

- Pump Maintenance Practices (pulled/serviced regularly)
    - Items to look for:

        - Screens on all well vents/all other vent
        - Changes in Sediment content & color of water
        - Raw water bacteriological test results
        - Leaks in the pump bowl/pump piping/pump
        - Clogs in the pump bowl/pump piping/pump Intake clogging.
        - Pump bowl levels in relation to the static water level and the pumping water level
        - Changes in pumping capacity (gallons/minute – gpm)
        - Changes in specific capacity (gpm/ft2)
        - Food grade oil leaking
        - Condition of well grouting/gravel pack
        - Flooding of pump house
        - Height of pump base
        - Unauthorized pump house access
- Suction Line Under Constant Pressure (all pump types)
    - Items to look for:
        - Air relief devices on suction lines not working properly/not screened properly
        - Leaks in piping
        - Bad sample tap
        - Low/negative line pressure
        - Excessive line pressure
        - Pump cavitation
        - Pump not functioning as designed
        - Pump not properly sized
- Discharge and Service Line Under Constant Pressure
    - Items to look for:
        - Air relief devices on suction lines not working properly
        - Leaks in piping
        - Bad sample tap
        - Low/negative line pressure
        - Excessive line pressure
        - Very large water demand (volume/rate) after the pump
        - Pump not functioning as designed
        - Pump not properly sized
        - Water contact with aerators or any open air
- Backflow Protection
    - Items to look for:
        - Installation on all mandatory locations
        - Malfunctioning preventers
        - Location of unsafe samples in relation to location of backflow preventers.
        - Devices testing frequency (DSPS requirements)
- Check Valve
        - Installation on all mandatory locations
        - Malfunctioning valves
        - Location of unsafe samples in relation to location of valves.

Devices testing frequency (DSPS requirements)

Treatment Observations

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The treatment observations portion of a community system Level 2 assessment includes treatment units, chemicals, and systems and chemicals used for disinfection.

Treatment Units

The Level 2 assessment is similar to that of the sanitary survey. Pay particular attention to vents, screens, hatches, and potential cross-connections. Older equipment or lines that are not being used anymore should be disconnected from the system. These may be points of stagnation. In addition, discuss with the operator its functionality, operation, service schedule, and whether there were recent changes made. Finally, consider whether each unit being operated within its design parameters (i.e. volumetric loading rate, mass loading rate, surface loading rates, break-through rates, etc.).

Treatment Chemicals

This section covers treatment chemicals and how they influence treatment effectiveness. All treatment chemicals are required to be NSF approved, within age requirements, and maintained in sanitary condition. Where is it being purchased from? Examine the solution being used to determine whether it is in good sanitary condition and transferred and stored correctly.

Treatment chemicals have a purpose and the evaluator needs to determine whether it is satisfying that purposes. Examine how the chemicals are being used, historical feed rates, injection locations, testing program, and equipment servicing. Were recent changes made that affected treatment efficiency?

Chlorination System

This section covers chlorine treatment in more detail. Some of these systems are mandatory and failure, even transient events, has immediate health implications. Design, operation, and functionality are evaluated much the same way as that done during a sanitary survey. Are the chemical feed pumps or chlorinators operating within their design parameters? Is the injection locations appropriate? Is CT being maintained? Is their functioning backup equipment? Has there been any loss of treatment?

Evaluate historical operation and test data as well. What do the operator logs show? Is there a consistent chemical dose? What do the entry-point and distribution system monitoring results show?

UV System

This section covers UV treatment. These units are mostly used in smaller, non-municipal applications. Some of these systems are mandatory and failure, even transient events, have immediate health implications. Design, operation, and functionality are evaluated much the same way as that done during a sanitary survey. Is the unit sized appropriately and operating within those design parameters? Ensure the unit is not being bypassed and appropriate pretreatment filters are functioning. Is there a flow delay mechanism to allow proper warm-up? Has there been any loss of treatment? Is their functioning backup equipment?

Evaluate historical operation and test data as well. What do the operator logs show? Is UV wavelength within design and consistent? Are lamps being replaced or cleaned at regular intervals and what are those intervals

based on? If seasonal treatment is provided, is the unit properly vetted before being placed into service each season?

Surface Water Treatment Observations

Source Water

- **Source Water -** Source water (can be more than one source). Bacti, viruses, and crypto will always be in the source water. Any changes to "normal" conditions, also means a potential change in the amount of bacti, virus, crypto in the source water. The most common are:

  - Floods, Sanitary Sewer Overflow (SSO), wastewater plant upsets, heavy rains/runoff, spills, animal die-off, increased animal activity or amount of animals (e.g. birds, fish), ice/snow melt.
  - Human activity (dumping wastewater, intentional contamination).

  The main items to look at/look for are:

  - Changes in color/cloudiness of source water, SSO reporting, recent weather reports, news, USGS stream data, DNR spills report/hotline, and wind direction.

- **Monitoring Program (parameters tested and results) -** The monitoring program itself does not contribute directly to contamination but monitors for contamination and trends which could result in contamination. Causes are:

  - Not in compliance with monitoring requirements.
  - Not enough staff to keep the monitoring program up to standards.

  The main items to look at/look for are:

  - Any noncompliance with monitoring program requirements.
  - Data trends which could have predicted/led to contamination.
  - Unusual/odd anomalies in the data.

- **Sample Collection (location, method, and frequency) –**

See section 2.8.8(d) above.

Intakes and Shore Wells

- **Inspection Frequency, Functionality, Chemical feed, Intake Pipe Testing and Integrity -** Intakes and shore wells basically contain raw water which is the same quality as the source water. In addition to contamination of the source water, the following can also be the source of contamination:

  - Freezing
  - Intake depth too deep, intake pipe clogged/contaminated

- Floods, animals, humans,
- Biofilms
- Leaks, cracks, breaks which could allow contamination from grade level
- Ice/snow melt
- Cross connection
- Disinfection failure (if any applied before treatment)
- Zebra mussels
- Cannot back-flush intakes
- Bio-terrorism

In addition to the items to look at/look for under source water, look at/look for changes in the physical/chemical properties of the water in addition to any changes to the physical infrastructure. Due to uniqueness, evaluation and analysis of the data must be conducted by the OIC and verified by the water system engineer. In many cases, only the water system engineers can evaluate/analyze/summarize answers or solutions to the contamination.

The main items to look for:

- Clarity, water color, animal/human activity, breach of security
- Lake water level
- Shore well water level
- Televised video
- Addition of Source Water items above
- Odor issues
- Physical inspection data/results

Treatment

Treatment is where contaminants are removed and/or conditioned to meet the SDWA. Even though this is the case, it is also possible for treatment units to be contaminated or the source of contaminants. These items apply to all categories below:

- Independent or chain contamination to unit operations
- Treatment system not operating within design limits (above, below, short circuit)
- Food grade oil contamination
- SCADA/alarm system failure
- Sampling/monitoring errors /jar tests at each unit operation
- In-plant Cross-Connection
- In-plant waste stream
- Equipment change/upgrades
- Flooding
- Animal/insect infestation

Holistically, due to uniqueness of each system, evaluation and analysis of the data must be conducted by the OIC and verified by the water system engineer. In many cases, only the water system engineers can evaluate/analyze/summarize answers or solutions to the contamination.

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- **In-Plant Biological, Chemical, Physical Testing/Frequency -** Sampling results and their trends will indicate where the contamination is and when/where it is likely to start. Sampling results and their trends (bacti, color, odor, pH, alkal, temp, turbidity) - location/frequency/results at each unit operation

- **Management of Waste Streams -** Waste streams usually have contamination in them. The only way they can cause contamination is via a short circuit, cross connection (drainage, sludge, overflow), or clogging.

- **Pre-Sedimentation (operation, functionality, testing) -** Any changes or anything which would change the following:

    - Loading rate, detention time, overflow rate
    - Tube/plate settlers: drainage, application rate, flushing lines

- **Rapid Mix (operation, functionality, testing) -** Any changes or anything which would change the following:

    - G values at each basin
    - Turbidity
    - Jar test

- S**low Mix/Flocculation (operation, functionality, testing) -** Any changes or anything which would change the following:

    - Detention time, flow through velocity
    - Turbidity

- **Sedimentation (operation, functionality, testing) -** Any changes or anything which would change the following:

    - Velocity, detention time
    - Surface loading rate (gpm/ft2)
    - Turbidity

- **Filtration (operation, functionality, testing) -** Any changes or anything which would change the following:

    - Flow rate, influent/effluent sample results
    - Media type/depth
    - Chemical addition efficacy
    - Cross connections
    - Surface wash rate
    - Backwash rate
    - Backwash frequency/duration
    - Mudballs/air bubbles, hydraulic overloading

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- **Membrane Filtration -** Any changes or anything which would change the following:

    - Loading rates
    - Backwash/chemical cleaning frequency
    - Integrity tests

- **Clear Well (operation, functionality, testing) -** Any changes or anything which would change the following:

    - Physical breaches
    - Pumping capacity

- **Disinfection**

    - Ultra-violet Treatment: Any changes or anything which would change the following:

        - Contact time
        - Dosage levels (mW – s/cm2)
        - CT ratio

    - Ozone: Anything which would change the following:

        - pH, temperature, CT time

    - Chlorination/chloramines

        - Looking at/looking for any changes or anything which would change the following:
        - Residual levels (free and total)

- **Chemical Use -** Any changes or anything which would change the following:

    - Type of Chemicals (especially disinfection chemicals)
    - Chemical Manufacturer and NSF Approval
    - Chemical Transfer and Storage
    - Sanitary Condition of Chemicals (particularly phosphates)
    - Age of Solution
    - Application Location, Method, and Frequency
    - Feed System (design, control, operation, dosing consistency)
    - Injection (location, injector condition and servicing)
    - Dose (injection or delivery rate and dose consistency)
    - Back-up System

<u>Monitoring (EP Level)</u>

- **Turbidity (test location, monitoring frequency, and levels) -** Any of the follow can be the cause of contamination:

- Human/lab error, human/lab contamination
- Upstream treatment systems not running properly
- Introduction of bacti to unit operations not from source water (pre-sed to EP)

You should look for any changes or anything which would change the following:

- Visual observation
- NTU levels/frequency

- **Disinfection (test location, monitoring frequency, and levels) -** Any of the follow can be the cause of contamination:

  - Disinfection system not running properly (free/total)
  - Bad/contaminated chemicals

  You should look for any changes or anything which would change the following:

  - Dis residual levels/sampling frequency
  - EP and distribution system residuals

- **Minimum CT Inactivation Ratio -** Any of the follow can be the cause of contamination:

  - Inadequate CT inactivation levels at each unit operation
  - Operator errors

  You should look for any changes or anything which would change the following:

  - CT ratios for each and total unit operation

- **LT2 Microbial (test location, monitoring frequency, and levels) -** Any of the follow can be the cause of contamination:

  - Operator/lab error

  You should look for any changes or anything which would change the following:

  - Testing results/bacti and crypto
  - Bin level

Pressure Vessels and Booster Pump/Stations

<u>Pressure Vessels</u>

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The Level 2 assessment form includes evaluation of pressure vessels. The following information may be considered and/or verified during your assessment.

- **Flushing Method and Connections -** If there is only a single tank and a bypass is available it should be used during flushing/cleaning events to the extent possible in order to maintain water pressure to system during flushing event. With multiple tank configurations it may be possible to shut off one pressure tank at a time to perform flushing, cleaning, maintenance and disinfection while maintaining system pressure before moving on to the next tank. Because an operator can easily see into hatched tanks once hatch is removed, hatched tanks can be very thoroughly cleaned, properly inspected and maintained. Older tanks without hatches, dedicated drains, valves or pump to waste fittings on discharge lines may be very difficult to safely flush and historically may never have been. If the system includes one of these tanks and you suspect it may be the source of contamination you should consider recommending upgrade to a code conforming tank. Current code for new tanks requires galvanized or bladder type pressure tanks each be equipped with shut-off valve and pipe union with drain fitting. If drain fitting is threaded it must also have a vacuum breaker. Tanks equipped this way can be taken off line for cleaning. Tanks must be disinfected following inspection.

- **Flushing, Cleaning, and Inspection Frequency -** The buildup of biofilms, sediments and corrosion in hydro-pneumatic pressure tanks can provide areas where microbes are protected and can proliferate. These areas can act as continuing sources of bacterial contamination to the water system. Likewise, unmaintained gaskets, seals, sight glasses, air intakes as well as leaks in tanks (including very small ones that are not immediately obvious) provide a pathway for bacteria to contaminate the water supply via the pressure tanks. If the tanks are regularly inspected and cleaned/maintained, faulty items can be replaced and leaks as well as weak points in tank walls and points of corrosion can be identified and fixed. Hatched tanks are required under NR 810.13 to have interior inspections every 5 years which include removal of sediment, cleaning of biofilm, restoration of interior and exterior coating systems, repair of sight glasses and air volume control as well as exercising valves. Hydro-pneumatic tanks that don't have hatches can often be effectively drained/flushed and exterior inspections can be conducted to check and fix faulty components as well as leaks or signs of corrosion and pitting that may turn into future leaks. If tanks have not recently been cleaned, inspected or maintained prior to confirmed bacteria positive results, you may consider including this recommendation in the assessment. Most systems have raw water sampling taps before pressure tanks and entry point sampling taps after pressure tanks. Investigative sampling results from these locations may help clarify whether contamination originates in the well or at the pressure tank(s).

- **Metal Condition (pitting, corrosion, holes, buckling, etc.) -** Corrosion and pitting can result in a weakening of the tank walls resulting in leaks or buckling under operating conditions. If slight leaks are evident in areas with significant corrosion the areas should be reinforced, patched or tank should be replaced.

- **Sight Glass -** Look for cracks in sight glass. These cracks may not noticeably leak water but may create access point for bacteria. Water in sight glass is connected to water in tank but does not readily circulate with tank water and may be stagnant, particularly if water level remains relatively consistent in tank. Often times the sight glass is cloudy (mineral or bio deposits) and water level is not clearly shown. The sight glass should be removed and cleaned if this is the case. Because the sight glass is clear, light can enter it and the light may increase biological growth.

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- **Access Hatches, Seals, Gaskets, Penetration Points -** When tanks are cleaned and inspected access hatches, seals, gaskets and other penetration points should be inspected. Access hatches must be located 24 inches above grade and be lipped. Corrosion around hatches may need to be ground down before replacing seals/gaskets if hatch does not provide a good seal. The access hatch area on tanks is often reinforced due to anticipated heavier use opening and closing hatch. However, on some thinner walled older tanks the metal around the access hatches can become so degraded that hatch will not properly seal and continues to leak. Instead of properly replacing tanks with this problem sometimes it is seen that these leaking hatch covers get permanently welded into location. This practice is not recommended, tank replacement is the better choice.

- **Bladder Condition, Operation, Pressure, Recharge Frequency -** Bladder or diaphragm tanks have valves to add air, can have associated pressure relief valves/automatic air blow offs and are controlled by pressure operated start stop controls. If air inlet valve is opened during an inspection and water spits out with the air it is a sign that the bladder has holes/leaks in it, is vulnerable to contamination and needs to be replaced. Air pressure should be maintained and adjusted in all tanks according to manufacturer's specs and pressure needs of the system. If you notice that one tank is recharging more or less frequently than others of the same size it may be caused by incorrect pressurization or it could be caused by a leak in bladder. If recharge frequency remains skewed after correcting pressure anomalies and you suspect a leak in the bladder the tank should be replaced. The bladder tanks usually cannot be repaired.

- **Air Compressor Condition, Air Source, Intake Screen -** Check air compressor condition, intake screen should be 24 mesh and clear of residue. Air should be drawn from a clean clear area.

- **Air Release Valve Condition, Termination Point, Air Gap -** Check all air relief valves associated with tank and adjacent piping. Air relief valve piping should be at least 24 inches above grade and be terminated in a down turned U bend screened with 24 mesh screen. Air release valves may also discharge water and these discharges are sometimes piped toward floor drains. Proper air gaps should be present between floor/floor drain and piping as shorter air gaps may present a cross connection.

- **Pressure Gauge, Lines, Valves, Backflow Protection Devices -** Leaking valves and appurtenances should be fixed/replaced as they present entryways for bacteria. Backflow preventers must be sized appropriately. Failure of backflow protection devices is an obvious way for bacteria to enter system however detecting a failed backflow preventer may not be so obvious. Approved backflow preventers must be checked and maintained per manufacturers specs and must be sized base on Departmental approvals.

- **Multi-Tank Configuration: Dead-Ends Not Stagnant -** When multiple pressure tanks are configured on a single dead-end line off a pipe tee the water in the tanks at the end of the line may not be frequently exchanged, can become stagnant and could be a source of bacterial contamination. In these cases it may be better to connect pressure tanks individually to the main discharge line "riding the line", or have a looping line where line of pressure tanks is connected to discharge line in more than one location.

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- **Extra Tanks Disconnected -** Unused tanks may contain residual stagnant water. Valves can leak or valve handles can get bumped resulting in partially open valves. When unused tanks are still connected to system stagnant water from unused tank may enter system through these partially closed or leaky valves. For this reason unused tanks should be completely disconnected from system instead of just valved off.

- **Operating Pressures -** Systems pressure should be set to run at a minimum of 35 psi. Typical on/off settings for a pressure switch is 40/60 psi. If system pressure decreases below 20 psi system is susceptible to having water enter distribution lines at joints or cracks in piping and disinfection may be required by the Department in response to the drops in pressure. Systems are allowed to run at pressures up to 100 psi but pressures exceeding 80 psi are known to cause leaks in distribution piping particularly for older, less robust or more fragile systems. Pressure reducing devices can be added to systems or portions of systems where pressures are too high. If you have experienced either higher or lower pressures than those outlined above prior to a confirmed bacteria detection you may need to monitor system pressure at various points, search for leaks and disinfect.

<u>Booster Pumps/Stations</u>

- Booster pumps are typically used to increase pressure to parts of systems which cannot otherwise maintain a minimum pressure of 35 psi. These may also be used to pull water from in ground reservoirs or used to maintain higher fire suppression pressures.

- When inspecting booster pumps look for leaks around base, determine when seals were last replaced/maintained and check for signs that seals may need to be replaced (corrosion or mineral deposits on pump casing joints). Water seals should be of same sanitary quality as water being pumped. If break tanks are used to maintain water seals they should have an air gap of 6 inches or two pipe diameters between feeder line and spill line of tank. Check air relief valves on nearby piping. System pressure gauges should be checked to make sure they are correctly connected to line, working well and accurately reflect pressures they are measuring.

- Booster pumps operate in the 35 to 100 psi range. If pressures are much higher than expected leaks can occur in piping and if pressures are much lower than expected contaminated water can enter lines. Low pressure alarm should be set to disable booster pumps when pressure drops below 20 psi. Suction lifts can be allowed in stations only for distances of less than 15 feet and at least 3 psi suction pressure must be maintained with automatic cut off if pressure drops below 3 psi in line. Boosted zones without elevated storage must have auxiliary means of maintaining pressure in boosted zone (pressure tanks, continuously running pump(s) etc).

- Pumping stations should be dry, secure, landscaped to move surface water away from building, have floor drain with floor 6 inches above grade and 2 feet above flood plain, have adequate heating, venting, lighting and dehumidification. Underground pumping station must have sump pump or other discharge to ground surface, access manways that are 24 inches above ground with overlapping locking cover,

vents and sump pump outlets must be 24 inches above ground with downward facing U bend and covered by 24 mesh screen.

Water Storage Facility

Section I of the Level 2 form provides a list of water storage facility problems/conditions that may be the cause of bacterial contamination during a coliform contamination event. The Level 2 Assessment should include an evaluation of the water system's storage to determine if it is a source of bacterial contamination. Typical storage facilities found at community water systems include ground storage reservoirs, elevated storage tanks and hydropneumatic tanks. It is common for community systems to have several water storage facilities. The assessment should include a review of the following:

- **Cleaning and Inspection Records -** Water storage facilities must be inspected on a minimum frequency of five years, drained on a minimum frequency of ten years. In addition, operators must inspect vents, overflow screens and hatches annually (NR 810.14). Records and reports of all inspections and maintenance should be reviewed for possible bacteria contributing factors such as missing hatch gaskets, unscreened openings, inadequate cleaning and debris. Many of the potential contamination sources are difficult to assess without a recent inspection report. It may be necessary for system to contact a professional tank inspection firm or registered professional engineer (for facilities 10,000 gallons or greater) to have an inspection performed.

- **Roof and Membrane Condition -** Check the visible and accessible portions of the roof and membrane for cracking and verify that all seams, openings and joints are adequately sealed. A soak down test may be needed to determine whether or not water is leaking into the structure(s).

- **Wall and Floor Condition -** Check all visible and accessible portions of the structure(s) for cracking and verify that all seams and joints are adequately sealed.

- **Operating Levels (depth or pressure) -** Discuss this topic with the system operator to determine how the operating levels are determined, what those settings are and what instrumentation is involved. Recent changes to operating levels or malfunctioning instrumentation could be causing a change in system pressure or an increase in water age/stagnant water resulting in bacteria problems.

- **Vents, Overflow Pipes and Screens -** Ensure that all vents and over flow pipes are structurally sound and are not damaged. Elevated storage tanks and stand pipes are required to have a 4-mesh screen on overflows and ground storage structures are required to be screened with a 24-mesh screen(NR 811.64).

- **Hatches -** Verify that all hatches have adequate seals between the hatch and the structure. The hatch door should be overlapping with a gasket where the hatch door meets the hatch riser.

- **Penetration Points -** Any void space between the structure and pipes, vents, or other openings projecting out of the structure should be adequately sealed.

- **Water Quality Observation -** If accessible, visually inspect the stored water and inside of the storage facility to check for signs of contamination or debris.

- **Security -** All hatches should be checked to ensure that they are properly locked to prevent unauthorized access. Also check for signs of vandalism or forced entry.

- **Overall Integrity -** Inspect the structure, to the extent possible, for corrosion, damage or disrepair. Recent inspection reports should provide information on the areas of the structure that are not easily visible or accessible.

Distribution

Section J of the Level 2 form provides a list of distribution system issues that may be the cause of bacterial contamination during a coliform positive event. Distribution systems at community systems consist of all pipes or conduits by which water is delivered to consumers except piping and fixtures inside buildings served water services and privately owned water mains. The elements that should be taken into consideration are the following:

- **Other Sources of Water Entering the System (interconnections) -** Verify that all interconnections to the system have been approved and that all registered back flow preventers associated with those interconnections have been recently tested. If possible, verify that other permitted wells in the system are not interconnected.

- **Private Water Main/Service Loop (Backflow Protection) -** Verify that all privately owned water mains connected to the publicly owned distribution system at more than one point have a check valve installed at each connection to the distribution system to prevent water from flowing back into the distribution system. Each check valve must be located in a manhole or vault which is accessible to the system operators for inspection. An inspection of these check valves may be needed to ensure they are functioning properly. Some older installations may not contain the necessary check valves to protect the system.

- **Cross-Connection Inspection Program -** All community water systems should have a functioning cross-connection inspection program. Check over cross-connection inspection forms to confirm that inspections are occurring at the required frequency for each customer classification. Also discuss the cross-connection inspection process with the system operator and verify that inspectors are properly trained and qualified. Review all registered backflow preventers in the system to confirm that they have been tested in the past year.

- **Air Relief Valves and Venting -** Systems containing air relief valves and/or venting should have an inspection and maintenance plan for those features. Automatic air relief valves should not be installed in areas where flooding of the manhole of chamber may occur. The open end of the air relief valves must extend to the top of the manhole or chamber, downward facing and be adequately screened(NR 811.72). Periodic inspection and testing should be conducted to verify that these are functioning properly.

- **Pressure Reducing Valves -** Pressure reducing valves should be installed in a secure and accessible location such that it can be cleaned and inspected. Periodic testing of the valve should take place to

ensure it is functioning properly and that pressures on both sides of the valve are within an acceptable range.

- **Pressure -** Low pressure situations can pull contamination into the system. Review recent storage facility level records, customer complaint logs, SCADA alarms and other information that may indicate that the system has experience a low pressure situation. System operators may also have information or records pertaining to system maintenance, main breaks or other factors that could have resulted in a significant pressure loss.

- **Flushing Program -** Review the systems flushing program to ensure that sediment and poor quality water is being periodically flushed from the system. Discuss flushing practices with the system operator and review flushing logs to determine the frequency, method and effectiveness. Customer complaint logs may indicate flaws in the flushing program.

- **Water Loss -** Review the recent PSC reports, monthly pumpage reports and onsite log books to determine whether or not there has been a change in the amount of water loss in the system. A high water loss may indicate system leaks or other issues that could be causing back siphonage or other contamination.

- **Water Mains, Valves, Hydrants -** Review the distribution system map and maintenance logs to confirm that adequate maintenance is occurring. The system operators should have records indicating the age of each of these system components along with maintenance and replacement plan to ensure the older components are being replaced before problems arise. A localized high number of main breaks may also indicate that the water main is in poor condition or was poorly installed. Recently installed components can be sources of contamination if not properly handled and disinfected.

- **Dead Ends/Zones -** Dead ends typically need to be flushed more often than other areas of the distribution system. Review bacteriological sample history, sample site plan, customer complaint logs and flushing records to verify that dead ends are being flushed as needed.

- **System Use and Integrity -** The age and condition of system components should be reviewed along with any recent changes in flow patterns in the system. A change in flow pattern can result in decreased flow and increased stagnation in portions of the system. The system may have to consider increased flushing and/or replacement of older or oversized portions of the system if stagnation is causing water quality problems.

- **Pressure Consistency -** Review of tower levels, customer complaint logs and maintenance logs may indicate recent pressure fluctuations in the system. Pressure fluctuations can cause back pressure/back siphonage problems, water hammer or other damage to plumbing systems that could result in bacterial contamination.

- **Distribution System Chlorine Testing Program -** Review the distribution system chlorine residual levels along with the residual sample locations. Speak with the system operator about the residual sampling procedure and site selection to ensure that the residual levels measured are giving a true indication of the typical and lowest levels in the system. Also, verify that the selected sites are sufficiently spread throughout the system.

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NON-COMMUNITY LEVEL 2 ASSESSMENTS

Event Background
Section A, Event Background Information, of the Level 2 assessment form provides a list of background issues that may be the cause of bacterial contamination during a total coliform or *E.coli* positive event. The events that are most common at TN and NN Public Water Systems are the following:

- **Changes in Water Quality (taste, odor, appearance)-** The following may indicate bacterial contamination:
    - The taste of the water has changed.
    - The smell of the water is different.
    - The appearance of the water is altered.
    - The water may taste metallic or musty.
    - The water may smell like rotten eggs or other unpleasant odor.
    - The water may be a strange color, or have debris, bugs or animals in it.

  Distribution System Inactive (closed, seasonal)- The distribution system may have been drained, inactive for a long time period, or have had limited use of the water which contributed to coliform contamination. Seasonal systems and existing systems that were closed for public use may experience this problem. Evaluate these types of systems for deficiencies in the distribution system. A seasonal system that didn't follow the proper steps listed in the Seasonal System Start-Up procedure may also contribute to coliform contamination in a water sample.

- **Loss of Pressure-** Sometimes a loss of pressure occurs because of power loss. A loss of pressure could also occur because of water system work. A portion of the distribution system could lose pressure due to leaks or greater water demand on the system than it is designed for. During these events bacteria can possibly enter the Public Water System and contribute to contamination.

- **Nearby land use activity is a potential source (blasting, fire suppression, land spreading, septic issues)-** Area land use can contribute to bacterial contamination. Blasting for construction or mining could possibly create fractures in the geology of the area and create direct conduits for contamination to enter the well. Fire suppression activities in the area could also be a potential source of contamination. Impacts from high capacity wells may impact other area wells. The extra amounts of water used from the aquifer and the excess amounts of water seeping into the aquifer can create water table fluctuations that can change the depth and flow pattern of surface contamination towards and existing public water supply well. Land spreading near a well is also a potential source of bacterial contamination. Groundwater contamination may occur from spills, over application of bio-solid applied to a field, and application on fields with shallow bedrock or spreading to close to features that have set separation distances. Onsite and nearby property septic system failures may contaminate the groundwater and affect a well that is susceptible because of the geology of the area.

- **Operation/Maintenance activities-** Recent operation and maintenance activities like exercising valves, flushing lines, storage tank repair/replacement, and pump replacement, may contribute to contamination entering the system. Recent treatment system work on sediment filters, ion exchange systems, chemical feed pumps, or chlorination equipment may introduce bacteria into the water system. Proper cleaning, testing, calibration, replacement, and maintenance reduce the chance of contamination entering the system from these sources.

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- **Recent drought conditions or extreme precipitation event(s))-** Recent drought conditions or extreme precipitation events occurring in the area, could cause the water table to fluctuate, or wells to be overtopped by flood water. When there are water table fluctuations, changes can occur introducing bacteria into the aquifer. Water levels could drop to below the submersible pump which could draw in new contaminants during drought conditions. Extreme precipitation events cause extra runoff to take place and that extra runoff could contain contaminants that could enter the well.

- **Possible sampling Procedure error-** Possible sampling procedure error could contribute to bacterial contamination in a public water supply system. Sampling procedure error can occur by not following sample collection guidelines:

  1. Remove the aerator and washer if present.
  2. Run water to determine if the faucet can deliver a smooth stream.
  3. Flame the faucet with a butane or propane torch at least 30 seconds. Make sure to flame the inside surface of the faucet with the flame. Do not touch the faucet after it has been flamed. If the faucet can't be flamed because of gaskets or plastic parts, but is otherwise a suitable site in the distribution system, it can be sterilized with bleach or alcohol.
  4. Run water for at least five minutes at medium strength so water isn't splashing too much.
  5. Fill bottle to fill line.
  6. Replace cap tightly, taking care not to touch the inside of bottle or cap.
  7. If you think you may have accidentally contaminated the sample do not send it to the lab. Discard the sample and bottle. Retake sample, using a new bottle and proper sample collection guidelines.

- **Poor sampling site selection-** Poor sampling site selection could contribute to bacterial contamination in the system. This can occur by not following the recommended sampling site selection guidelines:

  1. Select sampling points which are representative of the conditions of the distribution system.
  2. Remove any aerators, filters, or other devices from the tap before taking a sample.
  3. Select a sampling faucet least likely to give a false positive test result due to contamination at the discharge point.
     - Cold water taps only
     - Not connected to softener unless all the cold water is softened (sometimes additional sampling after a treatment device is useful in determining if the source of the contamination is in the treatment device)
     - Not threaded
     - Not from a flexible hose
     - Not from a drinking fountain
     - Not from faucet that cannot be thoroughly heat sterilized
     - Avoid faucets that cannot deliver a smooth stream of water

  4. Allow water to run at least five minutes prior to sample collection to flush out stagnant water in the lines.

- **Visible indicators of unsanitary conditions (vermin, animal waste)-** Check the area near the public water system and you see any live or dead animals, animal waste, garbage, animal hair, bugs, or beetles. These are visible indicators of unsanitary conditions and could contribute to bacterial contamination occurring in the public water supply system. Check the inside of the faucet aerator for insect parts too.

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- **Visible or scent indicators that a biofilm may be present-** If you observe visible indicators like shiny oily film in stagnant water (may see in the toilet tank) or foul smelling water, a biofilm may be present. The foul smell may get stronger as the age and density of the biofilm increases. Water systems that have been inactive may allow thicker biofilms to form.

Source Issues

Section B, Element 1 of the Level 2 form provides a list of source problems that may be the cause of bacterial contamination during a coliform contamination event. The source of water generally means the well head, aquifer, and surrounding recharge area. A thorough examination of construction issues and set-back distances to potential contamination sources is important when investigating contamination events. The following are the most common items to investigate.

- **Casing Height Low** – The well casing height shall be at least 12" above grade after 02/1991, >8"before 1991; > 2 ft above the regional flood elevation to prevent well from flooding, overtopping.

- **Conduit damaged/missing** (see pictures) **-** There shall be a conduit enclosing pump wires that prevents vermin and contaminants from entering the well. The conduit shall be threaded or otherwise tightly secured into the well cap and extend a minimum of 2 feet below grade. Where the conduit extends continuously from the well to a building or pump equipment enclosure, both ends of the conduit shall be sealed in a watertight and vermin-proof manner. When checking it, tug on the conduit to make sure it is intact in areas not readily observable.


Broken old metal conduit


Broken PVC electrical conduit


Missing electrical conduit

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Pump wires not completely enclosed


Pump wires out cap


Open elec. junction box & well

- **Contamination from nearby wells –** Nearby wells that are not up to code, have contamination problems, or are not properly filled and sealed if unused, can be a conduit for contamination to enter the aquifer and surrounding wells.

- **Floodwater/runoff ponding/topped well –** Landscaping around the well should not direct runoff toward the well casing where it can pond around the well. A flooded or overtopped well can allow contaminants to enter the well.

- **Grout or seal around well damaged –** Below are examples of wells with voids around the base of the well casing (e.g. broken cement, damaged grout, or open areas). This may allow surface contaminants to preferentially flow down the void and enter the well. This is especially problematic if the well is shallow.

- **Pit leaking/flooded -** A pit structure that is completely or partially below the ground surface, below a building floor, or in an alcove adjoining a basement used for housing of wells, offset pumps, or pressure tanks may not be constructed without prior approval of DNR. If these are not watertight or get flooded, they can cause contamination.

- **Vent damaged/unscreened -** If there is a well vent, it shall be downward facing, terminate at least 12" above floor, have an intact 0.25 sq. in. screen to prevent entry of vermin and contaminants into well.

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- **Well casing damaged/corroded -** A typical casing pipe is 1/4 inch thick, so it can corrode through if not protected. Inspectors should **never remove the cap** to determine casing thickness though. Inspectors should verify that the casing is not cracked, corroded or otherwise or damaged.

- **Well cap/seal damaged/defective/has openings/not vermin-proof** (see pictures) - The well casing shall be covered with an approved compression type well cap that seals the cap to the casing weather and vermin-proof without the use of caulk. If there is a non-vermin proof overlapping cap, it must be replaced if work is done in the well or the conduit is replaced. If it appears that an unapproved well cap may be the cause of bacterial contamination entering the well, it is a relatively inexpensive corrective action. Inspectors should verify the following:

    - The well cap, sanitary seal, or pump base are not cracked, otherwise damaged, or open.
    - A compression gasket may not be visible with some caps. Check the cap to verify it is sealed tightly to the casing. While it is acceptable to twist the cap a little to verify this, inspectors should not try and remove the cap. For cap designs where the neoprene "O-ring" gasket is visible on the sides of the cap, the gasket should be properly seated under the side bolts and show no signs of deterioration or tears.
    - Bolts are not loose or missing.
    - The wires, air lines, vents, discharge piping, chlorination ports, are properly sealed to prevent contaminants or vermin from entering the well. A professional job sealing the well does not include a temporary seal using calk or duct tape.


Open cap, warped gasket, broken conduit


Gasket sticking out, loose bolt


Well cap can be pulled off

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Cap caulked to seal side bolts)

Broken "O-ring" gasket

Gasket not seated properly (is over

Missing bolt, corroded

Cracked pump base, corroded

Overlapping cap (not vermin-proof)

- **Well construction unknown/not meet current code** – If there is no Well Construction Report (WCR), the well is likely old (at least pre-1987). It may not be properly grouted, cased, or otherwise constructed, or not meet required separation distances from pollution sources.

- **Well not protected from contaminants/vulnerable** – The well must be adequately separated from potential contaminants, such as septic systems, sewer lines, animal yards, and chemicals. The well must be in a sanitary location, and protected from vehicle damage. Especially vulnerable wells include:

    - shallow wells in sand and gravel, especially in agricultural areas or near surface waters, where contaminants (e.g. soluble nitrates) can readily move in the aquifer;
    - wells in limestone or karst with fissures that allow rapid movement of contaminants;
    - wells near streams and areas subject to flooding.

Pump facilities/controls, discharge piping

Section B, Element 2 of the Level 2 form provides a list of problems associated with pumps, facilities, and controls that may be the cause of bacterial contamination during a coliform contamination event.

- **Buried Suction Line** - The most common buried suction line that you will find is from a pitless adapter to an offset shallow well pump, or jet pump located in a building basement. The underground discharge from the well casing must be completed through an approved pitless adapter unit and through pressurized concentric piping. The conduit must be pressurized by means of a seal cross fitting or flange adapter installed in the basement end of the piping at the pump. Figures 34, 35, 36, 36a, 36b, and 36c in NR 812.32 show the most common configurations for buried suction lines. Installations not meeting 812 standards may cause the ability of contaminants to infiltrate the buried portion of the suction line.

- **Check Valve Non-complying Location/Failure** - Check valves may not be placed in the pump discharge pipe beyond a buried section of pipe between a well and pressure tank. The check valve shall be located at the top of the submersible pump, or in that portion of the discharge pipe before it becomes buried, or on the spool of an approved spool type pitless unit (NR 812.32 (4)(a)).

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- **Non-complying Flowing Well Piping** - Flowing wells are common in different parts of the state; however, many flowing wells are intermittent in nature so you may need to question the owner about the nature of their well. The discharge piping from a flowing well has to be controlled by a throttling valve. The overflow pipe most commonly comes through the well seal and needs to discharge at least 8 feet from the well. A drain inlet is allowed next to the well with the overflow pipe end at least two inches above the drain and the outlet end 8 feet from the well. Figures 41 – 43 in NR 812.32 show the complying pump and overflow piping installations.

- **Piping Leak/Ponding/Wet Along Buried Piping** – These elements should be discussed and observed as you walk the property with the owner. The recent replacement of leaking or bad water lines in the building or water standing in the lawn between the well and the building may be evidence of a continuing damaged water line and provides avenues for bacterial contamination to enter the system.

- **Power Loss** – The loss of power/pressure at a system for any length of time has the potential to allow for the loss of system pressure and possible back siphonage from attached devices/hoses, faucets without backflow protection, leaking buried lines.

- **Pump Failure/Replacement** – The replacement of a pump at a system is a common occurrence. This opening of the well to complete the pump work may allow for bacterial contamination to occur. The pump installer is required to chlorinate the well after their work; however, a poor chlorination is many times the problem.

- **Rope in Well** – Examine the well seal and make sure no rope or cable is interrupting the rubber gasket on the seal. NR 812.30(4) requires that no well seal can be used as a hold down device. This breakage in the gasket seal can allow contamination to enter the well.

Storage

Section B, Element 3 of the Level 2 form provides a list of water storage device problems that may be the cause of bacterial contamination during a coliform contamination event. TN and NN water systems typically use bladder style pressure tanks or steel hydropneumatic tanks (both buried and above ground) for storage. Also found at these systems, on a limited basis, are elevated tanks and ground storage reservoirs. The Level 2 assessment should include an evaluation of the water system's storage to determine if it is the source of bacterial contamination. The assessment should include a review of the following:

- **Waterlogged pressure tank**- This element should be looked at in conjunction with possible bladder deterioration. A waterlogged tank occurs when the pressure of the air inside the tank is below the specified range and there is more water in the tank than designed. This can occur when a hole develops in the bladder for a bladder type tank, or there is not enough air in the tank for an air interface type, and the tank fills with water or when there is a leaking Schrader valve (which is used to recharge the tank with air or remove air so it is the correct pressure). If, while performing the assessment, it is noticed that the pump continuously cycles and the water pressure within the building fluctuates with the pump cycle, then in all likelihood the pressure tank is waterlogged. Anytime the drinking water comes into contact with the "Air" side of the pressure tank, there is the possibility for bacterial contamination.

- **Pressure not holding with no water demand**- If it is noticed during the assessment that the water pressure is falling without any of the building faucets running, then there is the possibility that the

bladder has failed, the or the outside integrity of the tank, or the Schrader valve has been compromised. It may also be a failed check valve in well discharge piping.

- **Tank deterioration, rust, holes**- Obvious signs of flaking rust with dripping and pooling water coming from the pressure tank, often accompanied with water pressure not holding, is a sign that the tank may be the problem. Tank replacement may correct the contamination event.

- **Tank recently replaced**- Occasionally, when pressure tanks are replaced, the installer does not use sanitary installation techniques, or the tank interior may have been exposed to contamination prior to installation. This can lead to the pressure tank and water system becoming contaminated with bacteria.

Treatment

Section B, Element 4 of this form provides a list of water treatment device problems that may be the cause of bacterial contamination during a coliform positive event. Typical whole system treatment devices found at NN's and TN's are: ion exchange water softeners, iron removal systems (iron curtains), and in-line sediment filters. Occasionally in some areas of the state, UV treatment and in-line chlorinators are used. The elements that should be taken into consideration are as follows:

- **Broken Part(s) system malfunction-** Broken parts and/or malfunctioning treatment systems could promote favorable conditions for bacterial growth, resulting in bacteriological contamination of the water system.

- **Interruption in treatment/power loss-** If UV, in-line chlorination, or other similar sanitizing system is being used to control a primary drinking water contaminant; it could also be treating the raw water from the well for bacterial contamination. If this treatment is interrupted, and there is bacterial contamination in the well, bacterial contamination may pass through the inactive treatment system and enter the distribution system. Most UV systems have an approved s solenoid valve which will prevent water from entering the distribution system. A few UV systems have a bypass that would have to be manually turned by staff in emergency situations and then posting should be implemented for a boil water advisory. Untreated water is also a concern if significant repairs/replacement parts are installed on the system. If the distribution system was not disinfected after this type of event it is possible that bacteria could establish themselves in the distribution side causing coliform issues.

  Also, treatment system devices used for treating secondary contaminants (Ion exchange softeners and iron removal systems) that are connected to the distribution system may promote favorable conditions for bacterial growth. Inactive treatment systems that remain connected to the water system may be the cause of water system contamination. The media in the softeners may have become contaminated and needs to be changed.

- **Filter(s) not maintained-** If inline sediment/particle filters are not replaced at regular intervals, bacteria biofilm may begin to grow within the old filter which could lead to water system contamination.

- **Required chemical or salt addition missed-** Ensure the proper chemical is being added to the water and/or treatment system. Inspect the ion exchange softener brine tank to confirm it is filled with salt. The operation of the water treatment systems without the proper type and amount of chemical may increase the potential for bacteria to get introduced to the water system at the point of treatment.

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- **Recent installation/repair-** The installation or repair of a water treatment system may introduce bacteria to the water system from contaminated new parts. It is critical that the well drillers, pump installers and plumbing professionals use "sanitary" repair and installation techniques.

- **Required maintenance past due (i.e. light replacement) -** Any past due required maintenance that has not been completed may contribute to bacterial contamination of the water system.

- **Testing/maintenance records not completed (on site testing records)-** A review of any documentation that has to do with the testing of water being treated and any chemical addition should be completed. Any missing records or incomplete documents could be a clue that the source of the contamination potentially started with the treatment system.

Distribution System

Section B, Element 5 of the Level 2 form provides a list of distribution system issues that may be the cause of bacterial contamination during a coliform positive event. Distribution systems at TNs and NNs consist of all piping and plumbing areas in the system that water from the well passes through. The Level 2 assessment should include an evaluation of the water system's entire distribution system to determine if it is the source of the bacterial contamination, unless the size and complexity of the distribution system makes this impractical. The elements that should be taken into consideration are the following:

- **Cross Connections-** Are a connection or potential connection between any part of the water supply system and another environment containing substances that, under any circumstances, would allow the substances to enter the water supply system by means of back siphonage or back pressure. (NR812.07(27t)). Cross-connections between a potable water supply source and a non-potable source are areas where it is possible for bacteria and other contaminants to enter the water supply system. NR 812.27(9) states: "Potable water supplies shall be protected to prevent backflow, back-siphonage, and cross-connections according to the requirements in s. SPS.382.41 and s. 812.32 (1)(f)."

    - **Air Gaps Missing-** An air gap means the unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet supplying water to a tank or plumbing fixture and the flood level rim or spill level of the receptacle (NR812. 07(1p)). Examples of this are the distance between the faucet and the top of the sink or between a drain from the water softener or water heater and the floor. When air gaps are not present or too small, bacteria and other contaminants could enter the distribution system in these areas.

    - **Vacuum Breaker/Backflow Protection Device Missing or Device Required Testing Not Current-** Facilities may have threaded sample taps or other threaded hose connections without built in anti-siphon devices. DNR code requires (see note below) that vacuum breakers or other backflow protection be installed to prevent bacteria and other contaminants from entering the water supply system in compliance with Department of Safety and Professional Services code.

  NOTE: Section NR 810.15 prohibits cross connections, but authority to enforce this after the pressure tank resides with DSPS. It is important to point out the cross connections that are observed and explain the potential to impact the water system. If the cross connections are considered a likely source of bacterial contamination in a water system a DSPS inspector or plumber that is well trained in identifying cross connections may be contacted for assistance.

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- **Dead end Plumbing Lines/Devices not in use-** Dead end plumbing lines can occur at water systems, especially in older facilities. Dead end plumbing lines are branches of the distribution system that terminate by means of a plug, cap, or other closed fitting. Dead end plumbing lines are parts of the distribution system where flow is limited or non-existent and water becomes stagnant. These plumbing lines are areas where bacteria like to grow and could cause bacteria to enter the distribution system. When there are devices installed in the plumbing lines (usually inline sediment filters) that are not in use, they are also areas where bacteria can get trapped and grow and could possibly enter the distribution system causing contamination. In seasonal systems, there may be openings where parts, such as water meters, have been removed for the winter. These openings can allow vermin and other contaminants to enter the system.

- **Leaking Distribution Piping-** Leaking distribution piping can occur in a distribution system. This can be found by water staining on the floor, wall, or ceiling, or dripping coming from the piping. Leaking distribution system piping can occur anywhere; from the middle of the piping to near a fixture attachment. It can be found quite easily by following the distribution system piping in the facility. It can be fixed by either replacing the piping or, tightening or replacing the fixture. A leaky distribution system may allow bacteria to enter.

- **Low Pressure Event-** Low pressure events most often occur when power is lost or a portion of the distribution system fails. During these events bacteria can possibly enter the distribution system piping and cause bacteria contamination to the water supply. Pressure falling below 20 psi is of particular concern.

- **Low Temperature Setting on Water Heater (Encourages Biofilm Growth)-** When a hot water heater is set on the low temperature setting and the heat is not turned up for long periods of time, it could harbor bacteria and encourage biofilm growth that could enter the distribution system and cause bacteria to enter the water supply.

- **New Piping/Addition Installed-** Sometimes facilities replace their distribution system piping because they had a problem with it (ex. Lead piping, leaking, broken, rusted) or they add on to their facilities and need to add additional distribution piping to the water supply system. When piping is replaced or new additional distribution piping is installed and it is not properly chlorinated it can sometimes cause bacteria to enter the water supply.

Pressure Tank Guide

Manufacturer	Model	Volume – Gallons
Air-E-Tainer (Flint & Walling)	AT15	4
	AT25	9
	AT44	14
	AT66	20
	AT122	33
	AT144	44
	AT211	62
	AT244	81
	AT366	119
	42TGLV	42
	42SGLV	42
	80GLV	80
	120GLV	120
A.O. Smith	PMC-2	1.98
	PMC-5	4.55
	PMC-100	9.25
	PMET-2	1.96
	PMET-5	4.55
	PMET-7	7.3
	PMET-14	14.6
	PMH-7	7.0
	PMH-14	13.9
	PMH-20	19.9
	PMI-2	2.0
	PMI-5	4.6
	PMI-7	7.0
	PMI-14	14.0
	PM-14	14.0
	PM-20	20.0
	PM-26	26.0
	PM-32	32.0
	PM-45	45.2
	PM-65	65.1
	PM-85	84.9
	PM-86	83.5
	PM-119	115.9
Aqua Air (Goulds or A.O. Smith)	V-6P	2
	V-15P	4.5
	V-25H	8.2
	V-25P	8.2
	V-45	13.9
	V-45B	13.9
	V-45H	13.9
	V-45MP	13.9
	V-45P	13.9
	V-45PST	13.9
	V-60	19.9
	V-60B	19.9
	V-60H	19.9
	V-60MP	19.9
	V-60PST	19.9
	V-80	25.9
	V-100	31.8
	V-100S	31.8

Manufacturer	Model	Volume – Gallons
Aqua Air (Goulds or A.O. Smith) - Continued	V-140	45.2
	V-140B	45.2
	V-200	65.1
	V-200B	65.1
	V-250	83.5
	V-260	84.9
	V-350	116
Baron (Amtrol)	BN4202	42
	BN6000	60
	BN8003	80
	BN8205	82
	BN10050	100
	BN12051	160
	BN17002	86
	BN17255	81
	BN17252	86
	BN22050	119
Challenger (Flexcon Industries)	PC44	14
	PC66	20
	PC88	26
	PC111	32
	PC122	33.4
	PC144	44
	PC211	62
	PC244	81
	PC266	85
	PC366	119
Champion or Clayton Mark	CH-14	14
	CH-20	20
	CH-26	26
	CH-32	32
	CH-34	34
	CH-44	44
	CH-62	62
	CH-81	81
	CH-86	86
	CH-119	119
	CH3001	14
	CH4202	20
	CH6000	26
	CH8003	32
	CH8205	34
	CH10050	44
	CH12050	62
	CH12051	62
	CH252	86
	CH17002	86
	CH17255	81
	CH17252	86
	CH22050	119
	CM12H	5.3
	CM40H	14
	CM-101	2.1
	CM-102	4.4

Manufacturer	Model	Volume – Gallons
Champion or Clayton Mark - Continued	CM-103	8.5
	CM-201	14
	CM-202	20
	CM202UG	20
	CM-203	32
	CM-250	44
	CM250UG	44
	CM-251	62
	CM-302	86
	CM-350	119
	CM1001	2
	CM1002	4.4
	CM1003	8.6
	CM3001	14
	CM4202	20
	CM8003	32
	CM8205	34
	CM10050	44
	CM12051	62
	CM17002	86
	CM22050	119
ConAire (Sta-Rite)	CA15	6
	CA-42	20
	CA-82T	32
	CA-120	44
	CA-220	86
Dayton (Flexcon)	3GVT8	44
	3GVU1	81
	3GVU2	119
	3P557	30
	3YA57	35
DuraMAC (McDonald or A.Y. McDonald Mfg. Co.)	16002-V2MH	2
	16005-V2MH	5
	16002-V3M	2
	16002-V3MPX	2
	16005-V3M	5
	16005-V3MP	2.1
	16005-V3MPX	5
	10667-V3M	7
	16012-V3MP	4.4
	16014-H4M	14
	16020MV4F	20
	16020-H4M	20
	16032MV4F	32
	16036MV4F	36
	16052MV5F	52
	16086MV5F	86
	16096MV5F	96
	16119MV5F	119
ERTG	ERTG-12A	12
	ERTG-21A	21
	ERTG-30A	30
	ERTG-42TA (tall)	42

Manufacturer	Model	Volume – Gallons
ERTG - Continued	ERTG-42SA (short)	42
	ERTG-82A	82
	ERTG-120A	120
	ERTG-220A	220
	ERTG-315A	315
Elbi	DH-25	6.5
	DV-100	27
	DV-200	53
	DWT-8	2.1
	DWT-18	5.0
	DWT-25	6.5
	DWT-25H	6.05
	DWT-50V	13
	DWT-50H	13.05
	DWT-80V	21
	DWT-100V	27
	DWT-150V	40
	DWT-200V	53
	DWT-300V	80
	DWT-450V	119
	DWT-500V	132
	DXT-8	2.1
	DXT-18	5.0
	DXT-24	6.5
	DXT-35	9.2
	DXT-50	13.0
	ES-140	140
	ES-190	190
	ES-225	225
	ES-268	268
	ES-320	320
	ES-388	388
	ES-375	375
	ES-450	450
	ES-535	535
	WTL-170	44
	WTL-200	53
	WTL-300	80
	WTL-400	105
	WTL-450	120
	WTL-500	132
	WTL-600	160
	WTL-800	210
	WTL-1000	265
	WTL-1200	320
	WTL-1400	370
	WTL-1600	420
	WTL-2000	530
	WTL-3000	790
	WTL-4000	1060
	WTL-5000	1320
	WTS-45	12
	WTS-80	21
	WTS-100	26.5
	WTS-140	37

Manufacturer	Model	Volume – Gallons
Elbi - Continued	XT-15	2.1
	XT-30	5.0
	XT-60	6.5
	XT-90	13
	XTV-30	13
	XTV-40	21
	XTV-60	27
	XTV-90	40
	XTV-100	53
	XTV-110	66
	XTV-160	80
Flexcon / Flexcon Industries	FT 18	4.5
	FT 18S	4.5
	FT 44	14
	FT 144	44
	FT266	85
	HTX 15	2.1
	HTX 30	4.5
	HTX 60	6
	HTX 90	15
	SXHT 30	15
	SXHT 40	20
	SXHT 60	33
	SXHT 90	44
	SXHT 110	62
	SXHT 160	81
	WH 8	2.1
	WH 32	8.5
	WH 18	4.5
	WHD320	85
	WWT-20	20
	WWT25	26
	WWT-35	32
	WWT-45	44
	WWT-65	62
	WWT-80	81
	WWT-120	119
Flexcon In-Well (Flexcon Industries)	IWSS 4	3.5
	IWSS 5	4
	IWPL 4	3.5
	IWPL 5	4.25
Flex 2 & Flex 2 Pro (Flexcon Industries)	H2P14	14
	H2P20	20
	H2P25	26
	H2P30	32
	H2P35	33.4
	H2P45	44
	H2P65	62
	H2P80	81
	H2P85	85
	H2P120	119
	H2PL15	15
	H2PL22	22
	H2PL35	35

Manufacturer	Model	Volume – Gallons
Flex 2 & Flex 2 Pro (Flexcon Industries) - Continued	H2PL38SQ	38
	H2PL50	50
	H2PL65	65
	H2PL82	82
	H2PL90	90
	H2PL120	119
	WWT14	14
	WWT20	20
	WWT25	26
	WWT30	32
	WWT35	33.4
	WWT45	44
	WWT65	62
	WWT80	81
	WWT85	85
	WWT120	119
Flex-Lite (Flexcon Industries)	FL 5	15
	FL 7	22
	FL 12	35
	FL 17	50
	FL 22	65
	FL 28	82
	FL 30	90
	FL 40	119
	FLS 40D	40
	FLS 80D	80
	FLS 120D	120
	FLU30	30
	FLU30EZ	30
	FLU40	40
	FLU40EZ	40
	FLU40S	40
	FLU40SEZ	40
	FLU80	80
	FLU80EZ	80
	FLU120	120
	FLU120EZ	120
	FLS40D	40
	FLS40SQ	40
	FLS80D	80
	FLS120D	120
Flint & Walling Air-E-Tainer	AT25	9
	AT44	14
	AT66	20
	AT122	33
	AT144	44
	AT211	62
	AT244	81
	AT366	119
	42TGLV	42
	42SGLV	42
	80GLV	80
	120GLV	120
Flotec	FP7100	6

Manufacturer	Model	Volume – Gallons
Flotec - Continued	FP7100H	6
	FP7105	6
	FP7107	13
	FP7110T	19
	FP7110TH	19
	FP7110	19
	FP7120	35
	FP7120-08	35
	FP7125	50
	FP7130	85
	FP7135	119
	FP7200	12
	FP7210	30
	FP7230	42
	FP7235	42
	FP7240	85
	FP7250	120
Goulds – Please See Hydro-Pro (Goulds)		
H2OW-TO (Water Worker)	HT-2B	2
	HT-4B	4
	HT6HB	6
	HT-8B	8
	HT14	14
	HT-14B	14
	HT-14HB	14
	HT20	20
	HT-20B	20
	HT-20HB	20
	HT-30B	30 / 26 (Mfg Info Is Conflicting)
	HT32	32
	HT-32B	32
	HT-44	44
	HT-44B	44
	HT62	62
	HT-62B	62
	HT86	86
	HT-86B	86
	HT119	119
	HT-119B	119
H2 PRO (Flexcon Industries)	FRO 122	3.2
	FRO 132	4.4
	FRO 1070	14
	H2P 14	14
	H2P 20	20
	H2P 25	26
	H2P 30	32
	H2P 35	33.4
	H2P 45	44
	H2P 65	62
	H2P 80	81
	H2P 85	85
	H2P 120	119
	WWT-14	14

Manufacturer	Model	Volume – Gallons
H2 PRO (Flexcon Industries) - Continued	WWT-20	20
	WWT-25	26
	WWT-30	32
	WWT-35	33.4
	WWT-45	44
	WWT-65	62
	WWT-80	81
	WWT-85	85
	WWT-120	119
Hydro-Pro (Goulds)	V-6P	2
	V-15P	4.5
	V-25H	8.2
	V-25P	8.2
	V-45	13.9
	V-45B	13.9
	V-45H	13.9
	V-45MP	13.9
	V-45P	13.9
	V-45PST	13.9
	V-45U	13.9
	V-60	19.9
	V-60B	19.9
	V-60H	19.9
	V-60MP	19.9
	V-60PST	19.9
	V-60U	19.9
	V-80	25.9
	V-80EX	25.9
	V-80EXU	25.9
	V-80U	25.9
	V-100	31.8
	V-100S	31.8
	V-100SU	31.8
	V-100U	31.8
	V-140	45.2
	V-140B	45.2
	V-140U	45.2
	V-200	65.1
	V-200B	65.1
	V-200U	65.1
	V-250	83.5
	V-250U	83.5
	V-260	84.9
	V-260U	84.9
	V-350	115.9
	V-350U	115.9
ITT – BELL & GOSSETT	WTA-401	18
	WTA-402	25
	WTA-403	34
	WTA-404	68
	WTA-405	90
	WTA-447	53
	WTA-448	80
	WTA-449	106
	WTA-45	132

Manufacturer	Model	Volume – Gallons
ITT – BELL & GOSSETT - Continued	WTA-451	158
	WTA-452	211
	WTA-453	264
	WTA-454	317
	WTA-455	370
	WTA-456	422
	WTA-457	528
In-Well Technologies		
Plastic In The Well Pressure Tank	PL 45	4.25
Stainless Steel In The Well Pressure Tank	NT-30 SS	3.5
	NT-50 SS	4
Jet Rite 2 (Flexcon Industries)	PJR6	2.1
	PJR15	4.8
	PJR20S	5.3
	PJR25	9
	PJR25S	9
	PJR44IL	14
	PJR44S	14
	PJR66S	20
McDermott		
PT2000 Pro Series Steel Pressure Tank	DPT-2	2
	DPT-5	5
	DPT-20E	20
	DPT-32E	32
	DPT-36E	36
	DPT-52E	52
	DPT-86E	86
	DPT-119E	119
Myers	PP 46	16
	PP 59	20
	PP 108	38
	PP 138	45
	PP 174	57
	PP 235	76
	PP 319	104
	WX 101	2
	WX 102	4.6
Perma Tank or Perma-Air (State)	20-80	80
	20-100	100
	24-125	125
	24-140	150
	24-175	175
	30-175	175
	30-200	200
	30-250	250
	30-300	300
	36-250	250
	36-300	300
	36-350	350
	36-400	400
	36-500	500
	42-375	375

Manufacturer	Model	Volume – Gallons
Perma Tank or Perma-Air (State) - Continued	42-450	450
	42-500	500
	42-600	600
	42-700	700
	42-800	800
	48-500	500
	48-600	600
	48-700	700
	48-750	750
	48-900	900
	48-1000	1000
	48-1250	1250
	48-1500	1500
	54-650	650
	54-750	750
	54-900	900
	54-1000	1000
	54-1200	1250
	54-1500	1500
	54-1800	1800
	60-800	800
	60-1000	1000
	60-1250	1250
	60-1500	1500
	60-1750	1750
	60-2000	2000
	66-1000	1000
	66-1500	1500
	66-2000	2000
	66-2500	2500
	72-2500	2500
	72-3000	3000
	72-3500	3500
	72-4000	4000
	84-4000	4000
	84-5000	5000
	84-6000	6000
	84-8000	8000
	96-7500	7500
	96-10000	10000
	96-12500	12500
	PIL-2	2
	PIL-5	4.6
	PIL-7	7.3
	PIL-14	14
	PAD-14	14
	PAD-20	20
	PAD-32	32
	PAD-36S	36
	PAD-52	52
	PAD-86	86
	PAD-96	96
	PAD-119	119
	PADH-7	7.3
	PADH-14	14
	PADH-20	20
	PCM-20	20

Manufacturer	Model	Volume – Gallons
Perma Tank or Perma-Air (State) - Continued	PCM-36	36
	PCM-52	52
	PCM-86	86
	PCMH-20	20
	PL-42T	42
	PL-42S	42
	PL-82	82
	PL-120	120
	PSD-14	14
	PSD-20	20
	PSD-32	32
	PSD-36S	36
	PSD-52	52
	PSD-86	86
	PSD-96	96
	PSD-119	119.5
	PZ-12	12
	PZ-21	21
	PZ-32	32
	PZ-42-T	42
	PZ-42-S	42
	PZ-82	82
	PZ-120	120
	PZ-220	220
	PZ-315	315
	PZ-480	480
	PZU-525	525
	PZU-900	900
	SBD-14	14
	SBD-20	20
	SBD-32	32
	SBD-36S	36
	SBD-52	52
	SBD-86	86
	SBD-96	96
	SBD-119	119.5
PROFLO	PF20	20
	PF26	32
	PF32	32
	PF34	34
	PF44	44
	PF62	62
	PF81	81
	PF86	86
	PF119	119
Pro-Line	CA3001	14
	CA4202	20
	CA6000	26
	CA8003	32
	CA8205	34
	CA10050	44
	CA12051	62
	CA17002	86
	CA17252	86
	CA17255	81

Manufacturer	Model	Volume – Gallons
Pro-Line - Continued	CA22050	119
	PL-14	14
	PL-20	20
	PL-26	26
	PL-34	34
	PL-44	44
	PL-62	62
	PL-81	81
	PL-86	86
	PL-119	119
	PL-252	86
ProLite (Flexcon Industries)	CSS15	15
	CSS22	22
	CSS35	35
	CSS50	50
	CSS65	65
	CSS82	82
	CSS90	90
	CSS120	119
Pro-Source or Pro-Source Plus (Sta-Rite)	AW30H	30
	AW42	42
	AW42T	42
	AW85	85
	AW120	120
	FAW40	40
	FAW85	85
	FAW119	119
	FCT40	40
	FCT85	85
	FCT119	119
	PS6-S02	6
	PS19S-T02	19
	PS19T-T02	19
	PS32-T03	32
	PS35-T05	35
	PS50-T50	50
	PS62-T51	62
	PS85-T52	85
	PS119-TR50	119
	PS6H-S05	6
	PS19H-S00	19
	PSC-14-4	14
	PSC-20-6	20
	PSC-30-9	30
	PSC-35-10	35
	PSC-40-12	40
	PSC-48-14	48
	PSC-60-20	60
	PSC-80-23	80
	PSC-85-25	85
	PSC-119-35	119
	PSP19S-T02	19
	PSP19T-T02	19
	PSP32-T03	32
	PSP35-T05	35

Manufacturer	Model	Volume – Gallons
Pro-Source or Pro-Source Plus (Sta-Rite) - Continued	PSP42S-T02	19
	PSP42T-T02	19
	PSP50-T50	50
	PSP62-T51	62
	PSP75T-T03	32
	PSP82T-T05	35
	PSP85-T52	85
	PSP119-TR50	119
	PSP120-T50	50
	PSP200-T51	62
	PSP220-T52	85
	PSP320-TR50	119
	PSP-FW20-6	20
	PSP-FW35-10	35
	PSP-FW40-12	40
	PSP-FW48-14	48
	PSP-FW60-18	60
	PSP-FW85-25	85
	PSP-FW119-35	119
Pump Mate (State)	PMD-14	14
	PMD-20	20
	PMD-36-S	36
	PMD-52	52
	PMD-86	86
	PMD-96	96
	PMD-119	119
	PMDH-7	7.3
	PMDH-14	14
	PMDH-20	20
	PMDI-2	2
	PMDI-5	4.6
	PMDI-7	7.3
	PMDI-14	14
	SPMD-14	14
	SPMD-20	20
	SPMD-31	31
	SPMD-36-S	36
	SPMD-52	52
	SPMD-86	86
	SPMD-96	96
	SPMD-119	119.5
	SPMDH-7	7.3
	SPMDH-14	14
	SPMDH-20	20
	SPMDI-2	2
	SPMDI-5	4.6
	SPMDI-7	7.3
	SPMDI-14	14
	SCMD-20	20
	SCMD-36	36
	SCMD-36-S	36
	SCMD-52	52
	SCMD-86	86
	SCMDH-20	20
	Z-12	12
	Z-21	21

Manufacturer	Model	Volume – Gallons
Pump Mate (State) - Continued	Z-32	32
	Z-82	82
	Z-120	120
	Z-220	220
	Z-315	315
	Z-480	480
	ZH-32-3	32
	ZT-42-T3	42
	ZS-42-S	42
	ZU-525	525
	ZU-900	900
Quick Tanks Inc	Q12V	12
	Q21V	21
	Q30V	30
	Q42V	42
	Q42VSQ	42
	Q82V	82
	Q120V	120
	Q220V	220
	Q315V	315
	Q525C	525
	Q900C	900
	Q480VSQ	480
	QHT1000	1009
	QHT1500	1472
	QHT2000	2027
	QHT2500	2477
	QHT3000	3492
	QHT3500	3492
	QHT4000	4021
	QHT4500	4440
	QHT5000	5064
	QHT6000	6112
	QHT7000	6964
	QHT8000	8068
	QHT9000	8812
	QHT10000	10300
	QHTC1000	1078
	QHTC1500	1540
	QHTC2000	2596
	QHTC2500	2596
	QHTC3000	3174
	QHTC3500	3607
	QHTC4000	4219
	QHTC4500	4635
	QHTC5000	5258
	QHTC6000	6398
	QHTC7000	7246
	QHTC8000	8498
	QHTC9000	9239
	QHTC10000	10719
Red Lion	RL2	2.1
	RL4	4.5
	RL6H	6.3
	RL8	8.5

Manufacturer	Model	Volume – Gallons
Red Lion - Continued	RL8H	8.5
	RL14	14
	RL14H	14
	RL20	20
	RLP20H	20
	RL33	33
	RL44	44
	RL62	62
	RL81	81
	RL119	119
Reliance	PMD-14	14
	PMD-20	20
	PMD-32	32
	PMD-36	36
	PMD-52	52
	PMD-65	65
	PMD-86	86
	PMD-119	119
	PMDH-7	7.3
	PMDH-14	14
	PMDH-20	20
	PMDI-2	2
	PMDI-5	4.5
	PMDI-7	7
	PMDI-14	14
	RG42T-4	42
	RG82-4	82
	RG120-4	120
Signature 2000 (Sta-Rite)	SR20-6S	20
	SR35-10S	35
	SR40-12S	40
	SR48-14S	48
	SR60-18	60
	SR85-25	85
	SR119-35	119
SidePort Fiberglass	SP-9	40
	SP-18	80
	SP-26	120
State Industries Pro Series Steel Glass Lined Tanks	PL42T	42
	PL82	82
	PL42S	42
	PL120	120
Trident and/or Trident Ultra (A.O. Smith)	TD-20	19.9
	TD-26	25.9
	TD-32	31.8
	TD-35	31.8
	TD-45	45.2
	TD-65	65.1
	TD-85	84.9
	TD-86	83.5
	TD-119	115.9
	TDU-14	13.9

Manufacturer	Model	Volume – Gallons
Trident and/or Trident Ultra (A.O. Smith) - Continued	TDU-20	19.9
	TDU-26	25.9
	TDU-32	31.8
	TDU-35	31.8
	TDU-45	45.2
	TDU-65	65.1
	TDU-85	84.9
	TDU-86	83.5
	TDU-119	115.9
	TDUB-14	13.9
	TDUB-20	19.9
	TDUB-45	45.2
	TDUB-65	65.1
	TDUH-7	7.3
	TDUH-14	13.9
	TDUH-20	19.9
	TDUI-2	1.9
	TDUI-5	4.8
	TDUI-7	7.3
	TDUI-14	13.9
	TDUP-14	13.9
	TDUP-20	19.9
Value-Well	VW-20	20
	VW-32	32
	VW-44	44
	VW-62	62
	VW-86	86
	VW-119	119
Water Worker	HT-2B	2
	HT-4B	4.4
	HT-6HB	5.3
	HT-8B	7.4
	HT-14B	14
	HT-14HB	14
	HT-20B	20
	HT-20HB	20
	HT-30B	26
	HT-32B	32
	HT-44B	44
	HT-62B	62
	HT-86B	86
	HT-119B	119
Well-Flo (Amtrol or American Granby)	WF-14	14
	WF-15	4.4
	WF-20	20
	WF-26	26
	WF-32	32
	WF-34	34
	WF-44	44
	WF-45	14
	WF-62	62
	WF-60	20
	WF-80	26
	WF-81	81

Manufacturer	Model	Volume – Gallons
Well-Flo (Amtrol or American Granby) - Continued	WF-86	86
	WF-100	32
	WF-110	34
	WF-119	119
	WF-140	44
	WF-200	62
	WF-252	86
	WF-255	81
	WF-260	86
	WP-360	119
WellMate or Well-Mate (Pentair or Structural Fibers)	H-7	30
	HP-9	40
	HP-8SQ	40
	HP-18	80
	HP-26	120
	RT-200	187
	RT-270	264
	UT-30	30
	UT-40	40
	UT-40SQ	40
	UT-80	80
	UT-120	120
	WM-2	4
	WM-4	14.5
	WM-6	19.8
	WM-6LP	19.3
	WM-9	29.5
	WM-9UG	29.5
	WM-10LP	34.5
	WM-12	40.3
	WM-12UG	40.3
	WM-14WB	47.1
	WM-20WB	60
	WM-23	79.6
	WM-25WB	86.7
	WM-35WB	119.7
	WM-60	187
	WM-80	264
Well-Rite (Flexcon Industries)	JR6	2.1
	JR6-01	2
	JR15	4.5
	JR15-02	4.4
	JR25	8.5
	JR25-03	9.2
	JR25S	8.5
	JR44S	14
	WR45	14
	WR45-01	14
	WR60	20
	WR60BG	20
	WR60-02	20
	WR80	26
	WR100	32
	WR100BG	32
	WR100-03	32

Manufacturer	Model	Volume – Gallons
Well-Rite (Flexcon Industries) - Continued	WR120	33.4
	WR140	44
	WR140BG	44
	WR140-01	44
	WR200	62
	WR200-02	62
	WR240	81
	WR260	85
	WR260-03	86
	WR360	119
	WR360-03	119
Well-X-Trol (Amtrol)	WX1-250	44
	WX1-251	62
	WX1-302	86
	WX-35-CL	10
	WX-35-L	10
	WX-50-CL	13
	WX-50-L	13
	WX-85-CL	22
	WX-85-L	22
	WX-100-CL	26
	WX-100-L	26
	WX-101	2
	WX-101-G	2
	WX-101TK	2
	WX-102	4.4
	WX-102-G	4.4
	WX-102TK	4.4
	WX-102-PS	4.4
	WX-102VFD	4.4
	WX-103	7.6
	WX-103-G	8.3
	WX-103-PS	8.6
	WX-104	10.3
	WX-104-G	10.3
	WX-104-OC	10.3
	WX-104-S	10.3
	WX-105-PS	5.3
	WX-110-PS	7.4
	WX-130-CL	34
	WX-130-L	34
	WX-165-CL	44
	WX-165-L	44
	WX-200	14
	WX-200	14
	WX-200-CL	53
	WX-200-L	53
	WX-200-PS	14
	WX-200-UG	14
	WX-201	14
	WX-201D	14
	WX-201D-G	14
	WX-201D-T	14
	WX-201-G	14
	WX-201-OC	14
	WX-201-T	14

Manufacturer	Model	Volume – Gallons
Well-X-Trol (Amtrol) - Continued	WX-202	20
	WX-202D	20
	WX-202D-G	20
	WX-202D-T	20
	WX-202-G	20
	WX-202-H	20
	WX-202-T	20
	WX-202TK	20
	WX-202TK P	20
	WX-202-OC	20
	WX-202P	20
	WX-202PA	20
	WX-202PA-G	20
	WX-202PA-T	20
	WX-202PS	20
	WX-202-UG	20
	WX-202XL	26
	WX-202XLD	26
	WX-202XLD-G	26
	WX-202XLD-T	26
	WX-202XL-G	26
	WX-202XLPA	26
	WX-202XLPA-G	26
	WX-202XLPA-T	26
	WX-202XL-T	26
	WX-202XLTK	26
	WX-202XLTK P	26
	WX-202XLP	26
	WX-203	32
	WX-203D	32
	WX-203D-G	32
	WX-203D-T	32
	WX-203-G	32
	WX-203P	32
	WX-203PA	32
	WX-203PA-G	32
	WX-203PA-T	32
	WX-203-T	32
	WX-203TK	32
	WX-203TK P	32
	WX-204	20
	WX-205	34
	WX-205D	34
	WX-205D-G	34
	WX-205D-T	34
	WX-205-G	34
	WX-205P	34
	WX-205PA	34
	WX-205PA-G	34
	WX-205PA-T	34
	WX-205-T	34
	WX-205TK	34
	WX-205TK P	34
	WX-250	44
	WX-250D	44
	WX-250D-G	44
	WX-250D-T	44

Manufacturer	Model	Volume – Gallons
Well-X-Trol (Amtrol) - Continued	WX-250-G	44
	WX-250P	44
	WX-250PA	44
	WX-250PA-G	44
	WX-250PA-T	44
	WX-250-T	44
	WX-250TK	44
	WX-250TK P	44
	WX-250-UG	44
	WX-251	62
	WX-251D	62
	WX-251D-G	62
	WX-251D-T	62
	WX-251-G	62
	WX-251P	62
	WX-251PA	62
	WX-251PA-G	62
	WX-251PA-T	62
	WX-251-T	62
	WX-251TK	62
	WX-251TK P	62
	WX-251-UG	62
	WX-252	86
	WX-255	81
	WX-255D	81
	WX-255D-G	81
	WX-255D-T	81
	WX-255-G	81
	WX-255P	81
	WX-255PA	81
	WX-255PA-G	81
	WX-255PA-T	81
	WX-255-T	81
	WX-255TK	81
	WX-255TK P	81
	WX-300-CL	80
	WX-300-L	80
	WX-302	86
	WX-302D	86
	WX-302D-G	86
	WX-302D-T	86
	WX-302-G	86
	WX-302P	86
	WX-302PA	86
	WX-302PA-G	86
	WX-302PA-T	86
	WX-302-T	86
	WX-302TK	86
	WX-302TK P	86
	WX-350	119
	WX-350D	119
	WX-350D-G	119
	WX-350D-T	119
	WX-350-G	119
	WX-350P	119
	WX-350PA	119
	WX-350PA-G	119

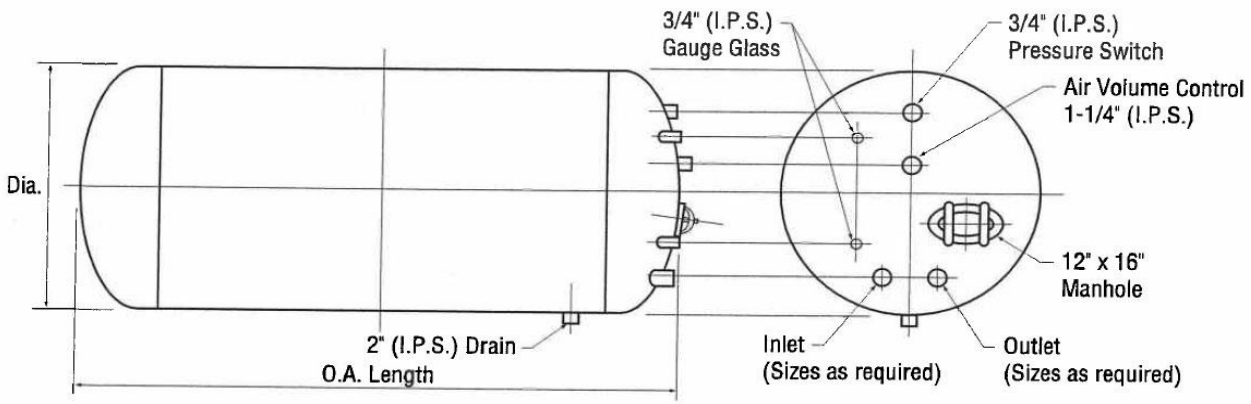
Manufacturer	Model	Volume – Gallons
Well-X-Trol (Amtrol) - Continued	WX-350PA-T	119
	WX-350-T	119
	WX-350TK	119
	WX-350TK P	119
	WX-400-CL	106
	WX-400-L	106
	WX-401	17.5
	WX-401-C	17.5
	WX-402	25
	WX-402-C	25
	WX-403	34
	WX-403-C	34
	WX-404	66
	WX-404-C	66
	WX-405	88
	WX-405-C	88
	WX-406	110
	WX-406-C	110
	WX-407	132
	WX-407-C	132
	WX-421	165
	WX-422	220
	WX-423	275
	WX-424	325
	WX-426	440
	WX-427	550
	WX-447	53
	WX-447-C	53
	WX-448	80
	WX-448-C	80
	WX-449	106
	WX-449-C	106
	WX-450	132
	WX-450-C	132
	WX-451	158
	WX-451-C	158
	WX-452	211
	WX-452-C	211
	WX-453	264
	WX-453-C	264
	WX-454	317
	WX-454-C	317
	WX-455	370
	WX-455-C	370
	WX-456	422
	WX-456-C	422
	WX-457	528
	WX-457-C	528
	WX-458-C	660
	WX-459-C	792
	WX-460-C	925
	WX-461-C	1056
	WX-462-C	1320
	WX-463-C	1980
	WX-500-CL	132
	WX-500-L	132
	WX-600-CL	158

Manufacturer	Model	Volume – Gallons
Well-X-Trol (Amtrol) - Continued	WX-600-L	158
Wessels / Wesselect /Westank	FXA 35	10
	FXA 50	13
	FXA 85	23
	FXA 130	35
	FXA 200	53
	FXA 300	79
	FXA 400	106
	FXA 500	132
	FXA 600	158
	FXA 700	185
	FXA 800L	211
	FXA 1000	264
	FXA 1200	317
	FXA 1400	370
	FXA 1600	422
	FXA 2000	528
	FXA 2500	660
	FXA 3000L	792
	FXA 3000L	792
	FXA 4000	1056
	FXA 5000	1320
	FXA 7500	1980
	FXA 10000	2640
	FXA 15000	3963
	FXT 400	8
	FXT 401	15
	FXT 402	25
	FXT 403	35
	FXT 404	70
	FXT 405	90
	FXT 415	115
	FXT 440	140
	FXT 460	160
	FXT 480	210
	GA 200V	200
	GA 200M	200
	GA 350M	350
	GA 400M	400
	GA 500M	500
	GA 750M	750
	GA1000M	1000
	GA1250M	1250
	GA1500M	1500
	NL 15	2.1
	NL 20	3.2
	NL 30	4.8
	NL 60	6.6
	NL 80L	10.6
	NL 90L	15.8
	NL 40VL	21.1
	NL 60VL	26.4
	NL 90VL	52.8
	NL110VL	79.2
	NL 160VL	132.1
	NLAP 40	11

Manufacturer	Model	Volume – Gallons
Wessels / Wesselect /Westank - Continued	NLAP 60	15
	NLAP 100	25
	NLAP 150	39
	NLAP 220	58
	NLAP 325	85
	NLAP 400	104
	NLAP 560	147
	NLAP 600	158
	NLAP 700	185
	NLAP 815	215
	NLAP 950	250
	NLAP 1100	290
	SSA 35	10
	SSA 50	13
	SSA 85	23
	SSA 130	35
	SSA 200	53
	SSA 300	79
	SSA 400	106
	SSA 500	132
	SSA 600	158
	SSA 700	185
	SSA 800	211
	SSA 1000	264
	SSA 1200	317
	SSA 1400	370
	SSA 1600	422
	SSA 2000	528
	SSA 2500	660
	SS12NA33	15
	SS12NA51	24
	SS14NA48	30
	SS14NA63	40
	SS16NA72	60
	SS20NA62	80
	SS20NA78	100
	SS24NA65	120
	SS24NA72	135
	SS30NA62	175
	SS30NA77	220
	SS30NA84	240
	SS36NA72	295
	SS36NA93	400
Standard Galvanized Pressure Tank Volumes and Dimensions	Tall: 16" w x 51" h	42 gal
	Short: 24" w x 32"h	42 gal
	20" w X 63" h	82 gal
	24" w X 64.5" h	120 gal
	30" w X 78" h	220 gal
	36" w X 87" h	315 gal
	36" w X 126" h (vertical or horizontal Can be stood up or laid down in cradles)	525 gal
	42" w X 160.5" h (vertical or horizontal Can be stood up or laid down in cradles)	925 gal

Manufacturer	Model	Volume – Gallons
QC61 Coated Galvanized Vertical High Pressure Tanks	HP12V	12
	HP21V	21
	HP30V	30
	HP42V	42
	HP42VSZ	42
	HP82V	82
	HP120V	120
	HP220V	220
	HP315V	315
	HP480VSQ	480

Volume of Large Steel Hydropneumatic Tanks



OA = overall length

Volume = total maximum interior including air + water
(less than calculated volume of cylinder due to curved tank ends)

Volume gallons	Diameter inches	Length inches	Volume gallons	Diameter inches	Length inches	Volume gallons	Diameter inches	Length inches
513	48	78	1134	66	88	2613	78	140
560	48	84	1312	66	100	3609	78	188
654	48	96	1490	66	112	1604	78	236
748	48	108	1668	66	124	3070	84	143
842	48	120	2023	66	148	4222	84	191
1030	48	144	2379	66	172	5373	84	239
1218	48	168	2735	66	196	7676	84	335
1406	48	192	3091	66	220	3579	90	146
712	54	87	1439	72	96	6223	90	242
840	54	99	1651	72	108	8867	90	338
959	54	111	1863	72	120	11510	90	434
1078	54	123	2075	72	132			
1316	54	147	2499	72	156			
1554	54	171	2932	72	180			
1792	54	195	3344	72	204			
912	60	90	3767	72	228			
1059	60	102	4190	72	252			
1206	60	114	4613	72	276			
1353	60	126	5036	72	300			
1647	60	150	5460	72	324			
1941	60	174						
2235	60	198						

(Courtesy Midwest Tank Co)

Last Updated: November 1, 2019