SUGGESTED PRACTICE FOR WATER WORKS

DESIGN, CONSTRUCTION AND OPERATION

FOR TYPE I PUBLIC WATER SUPPLIES

In accordance with the

Michigan Safe Drinking Water Act
1976 PA 399, as Amended,
and the Administrative Rules

Michigan Department of Environmental Quality
Water Bureau

February, 2008

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INTRODUCTION

When the Michigan Safe Drinking Water Act was promulgated in 1976, it was concluded that a manual of suggested practices was needed that could be used by all those involved in the design, construction and operation of public water supplies. In 1982, the first edition of Suggested Practice For Waterworks manual was developed which contained specific design, construction, operational and administrative criteria to assist state and local regulators to properly and consistently implement the state drinking water program.

Since the first edition of the manual was printed, the use of Recommended Standards For Water Works (aka Ten State Standards) became the reference manual of choice for both regulators and the regulated community. Suggested Practices became increasingly obsolete and was never updated until the DEQ Water Bureau decided to rewrite and update the manual in 2008.

This updated manual is indexed by part to coincide with the appropriate parts of Act 399 and is not intended to be a complete listing of every requirement or recommendation. It is to be used in conjunction with other reference materials. At the beginning of each part, recommended references are listed that should be reviewed before proceeding. Specific items listed in this manual are additional requirements or information that is not in the references.

Other important documents or reference materials that should be obtained and reviewed are:

Recommended Standards For Water Works prepared by the Great Lakes Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. The standards can be obtained from Health Educations Services of Albany, New York at (518) 439-7022 or www.hes.org.

Michigan Safe Drinking Water Act, PA 399 – can be downloaded from the DEQ website at http://www.michigan.gov/documents/deq/deq-wb-dwehs-cws-Act399_247583_7.pdf

Cross Connection Rules Manual – prepared by the DEQ Water Bureau. The manual can be obtained by calling the DEQ - Community Drinking Water Unit at (517) 241-1318.

DEQ Polices and Procedures – any referenced DEQ policy is contained in Appendix A

PART 5 CRITERIA FOR THE DETERMINATION OF MICHIGAN WATER SUPPLY TYPES

Applicable references

- Michigan Safe Drinking Water Act, Part 5
- DEQ-Water Bureau Policy, WB-013, *Classification of Public Water Supplies*

I. General

Major differences exist between Type I and other public water supplies; particularly in design, submission of construction plans, monitoring and reporting requirements, required number of wells, and standby power requirements. Major problems and real hardships could be imposed on water suppliers when a water supply classification is changed from a Type II or Type III to a Type I. Therefore, water suppliers should be advised of the differences in requirements during the design stage and water supplies should be established as Type I as early as possible. The below table summarizes how water systems are typically classified. Please refer to the *Classification of Public Water Supplies* policy in Appendix A for further information.

Types of Public Water Systems

<table>
<tr><th colspan="3">Classification</th><th>Description</th><th>Examples</th></tr>
<tr><td rowspan="4">Public Water System</td><td colspan="2">Type I
Community</td><td>Provides year-round service to ≥ 15 living units OR to ≥25 residents</td><td>Municipalities, subdivisions, apartments, condominiums, nursing homes, manufactured housing communities</td></tr>
<tr><td rowspan="2">Type II
Noncommunity</td><td>Nontransient</td><td>Serves ≥25 of the SAME individuals on an average daily basis for >6 months per year</td><td>Places of employment, schools, day-care centers, bottled water sources</td></tr>
<tr><td>Transient</td><td>Serves ≥25 individuals or ≥15 service connections on an average daily basis for ≥60 days per year</td><td>Hotels, restaurants, campgrounds, churches, highway rest stops</td></tr>
<tr><td colspan="2">Type III</td><td>Public water system that is not a Type I or Type II</td><td>Subdivisions, apartments, condominiums, or duplexes with 2-14 living units, facilities serving <25 individuals or open <60 days per year</td></tr>
<tr><td colspan="3">Private Water System</td><td>Serves a single living unit</td><td>Single family home</td></tr>
</table>

Type II public water system are further classified based on water use:

Type IIa systems – the average daily water production is equal to or greater than 20,000 gallons per day, during the month of maximum water use.

Type IIb system – the average daily water production is less than 20,000 gallons per day during the month of maximum water use.

PART 7 SURVEILLANCE, INSPECTION, AND MONITORING

Applicable references

- Michigan Safe Drinking Water Act, Parts 4, 7 and 15
- DEQ-Water Bureau Policy, WD-03-018, *Turbidity Compliance Monitoring and Determination of Compliance With The Turbidity Treatment Technique Standard*

1. Water System Evaluations/Sanitary Surveys

   a. The Water Bureau considers on-site evaluations and sanitary surveys of water systems to be the highest priority drinking water program activity. Such evaluations and surveys will include all aspects of the waterworks system, including all of the following applicable elements for existing or potential health hazards for the purpose of determining the ability of the public water supply to reliably produce, treat, and distribute adequate quantities of water meeting state drinking water standards:
      1. Source
      2. Treatment
      3. Distribution system
      4. Finished water storage
      5. Pumps and pump facilities and controls
      6. Monitoring, reporting and data verification
      7. System management and operation
      8. Operator compliance with state requirements
      9. Cross connection control program
      10. Reliability of the waterworks system
      11. Security measures

   b. A complete evaluation/survey of all public water supply types (Subpart H & Complete Treatment Systems, Groundwater Systems, and Customer Systems) shall be conducted at least once every three years.

      The frequency specified above may be reduced or increased depending on the performance of the system and the results of the Water Bureau's review. Formal visits independent of the sanitary survey will also be conducted in accordance with the Water Bureau's goals.

2. Total Coliform Rule Guidance

Bacteriological Monitoring Sample Site Plan Guidance

<u>Determining the number of samples required:</u>
The number of routine total coliform samples a water supply must take each month is based on the number of people served as posted in Table 1 of the Safe Drinking Water Act. This information is the first step in drafting the bacteriological sampling site plan. If warranted, the Water Bureau may require more samples than the table indicates. Additional construction or repair related samples may be taken by the utility and not be included in the compliance sampling.

Choosing routine sampling sites:

The focus of performing bacteriologic sampling of the water system is to detect the potential for an introduction of contaminants to the water supply. These samples must be taken from representative sites within the distribution system to be able to detect this potential anywhere in the water supply.

a. *Location* - the locations chosen as sample sites should represent the entire system. The sample sites ultimately chosen should vary in geographic area, pressure districts and water use. It is beneficial to sample in different portions of the system so that a potential contamination event can be detected anywhere in the system, and as soon as possible. Water systems with different service areas or pressure districts should make an effort to sample each of these areas, as the boundaries may hinder the detection of contaminants on one side or the other. Water samples from transmission mains will provide a good indication of the quality of water moving through the system, but other areas of the distribution system may have less water movement and would provide a better indicator of the potential for re-growth of bacteria in the system.

b. *Access* - while choosing sampling sites, consideration should be made for access to the site. The operator may need to visit the site as often as weekly, so the owner of the property should be comfortable with that frequency. Also, in case of a positive sample result, access may be necessary during non-working hours and on weekends. The owner should be willing to grant access in case of such an event. Water works facilities located in the distribution system, such as elevated storage tanks, pump stations, or other municipally owned buildings are great candidates because they are accessible to the operator. Sites with seasonal usage, such as schools, are generally not good candidates due to potential access problems and periods of stagnant water.

c. *Access to Repeat Sampling Sites - a*nother factor to consider is access to repeat sampling sites. Each routine sampling site will require 2 repeat sampling sites, one upstream of the routine site, and one downstream. For supplies that collect only one routine sample each month, a fourth repeat site is necessary. The upstream and downstream repeat sites must be within 5 service connections of the routine sampling site. Access necessary to repeat sites is a little different than the access necessary to the routine site. These sites will not be sampled on a routine basis, and the property owner will not be as familiar with the operator as at the routine sample site. The repeat sites only need to be accessed when the routine site is found to have a positive test result. The ability to access the repeat sample sites is no less important than the ability to access the routine site, and proper consideration should be given to these sites as well. A routine sampling site should not be selected if adequate repeat sampling locations are not available. Dedicated sampling stations can be installed in locations where appropriate sites are not available.

d. *Sampling tap* - the sites chosen should have a sampling tap that will allow the operator to draw water from within the distribution system with a minimal risk of contaminating the sample during the sampling procedure. The ideal tap will have a small diameter flame proof line with a down-turned outlet, a smooth interior, exterior without any threads and controlled with a ¼ turn ball valve. If using standard faucets, they should have separate hot and cold water shutoffs. Taps that are completely supplied by a water softener should be avoided. The Water Bureau does not recommend the use of threaded taps, or sampling from

e. hydrants or hose bibs. These fixtures are difficult to disinfect prior to sampling and may harbor bacteria. The operator may have a difficult time getting a safe sample from these types of taps.

f. *Raw water sampling* - the Water Bureau recommends sampling water wells each month in addition to the required distribution samples. If coliform positive results are reported from the distribution system, these raw water samples can save the operator and the owner of the water supply a good deal of time if they indicate that the wells are not the source of the contamination. The Groundwater Rule will require that wells be sampled in response to a positive routine distribution sample.

<u>Sampling instructions:</u>
The sampling site plan should include instructions for the operator to follow. It is important for the operator to follow the same procedure each time sampling is conducted to avoid sampling errors or contamination of the sample.

The following items should be included in the instructions to ensure that the sampling is performed in the same manner each time:

- Note the removal of nozzles and aerators
- Sampling tap disinfection procedure
- Minimum time the line should be flushed prior to sampling
- Minimum chlorine residual measured prior to sampling
- Record chlorine residual at the time of sampling
- Note to maintain constant smooth stream of water
- Precautions for handling of empty bottle
- Specimen handling procedures and hold time
- Instructions for filling out the necessary paperwork for the sample
- Monthly sampling scheme (number of samples and frequency)
- Specify the use of a laboratory certified to perform the analysis

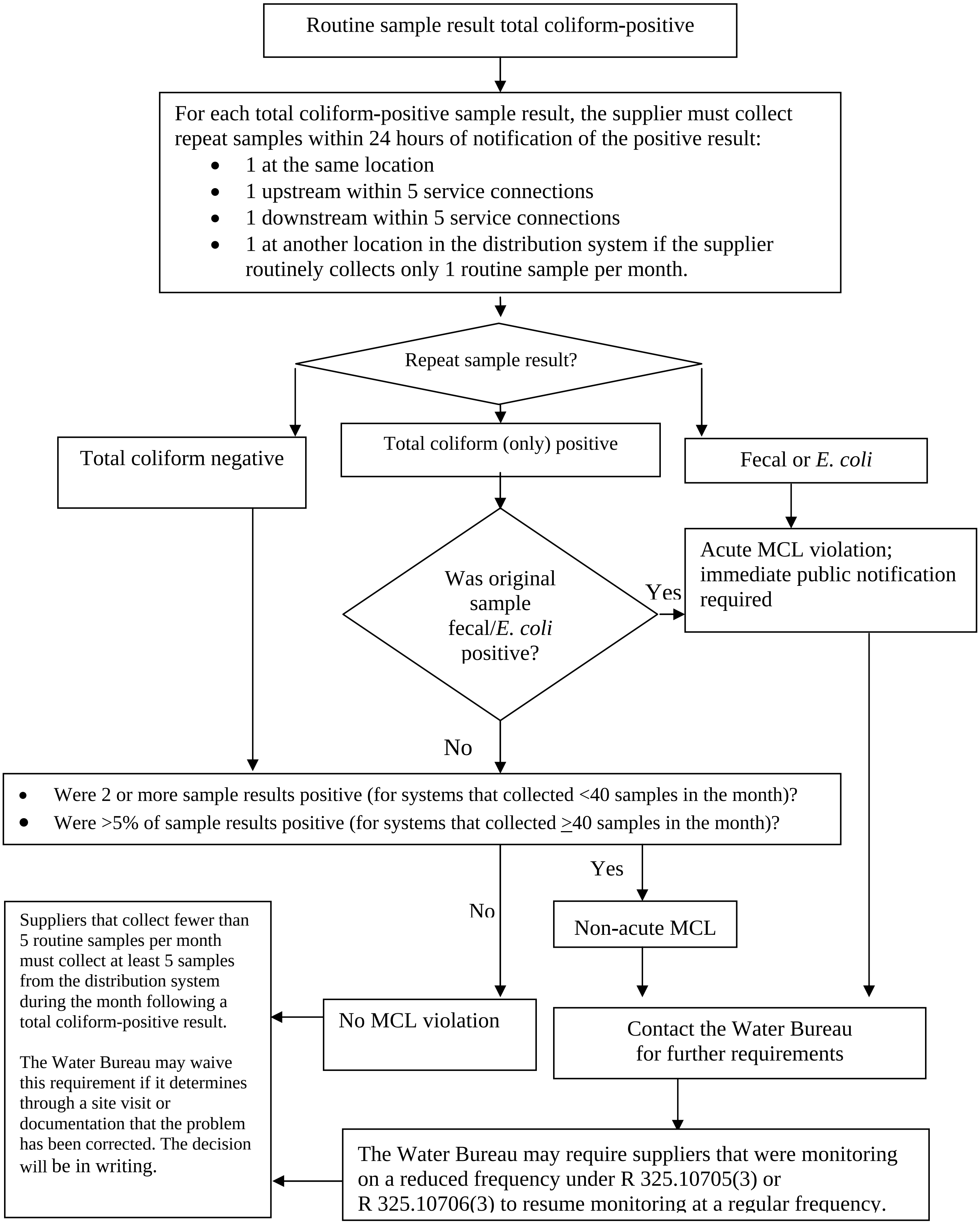
<u>Instructions to follow in case of a positive test result:</u>
The sampling site plan should provide a set of instructions for the operator to follow in the event that a distribution system sample is positive. The repeat sampling procedure should be detailed and include a list of contacts for well drillers, chemical suppliers, and the local media. Act 399 requires that the routine site be re-sampled, along with the appropriate upstream and downstream locations. If the supply routinely only collects one sample per month, one additional sample must be taken so that the total number of repeat samples is four.

Whenever a total coliform positive result is received from a routine distribution sample, it is recommended that the Water Bureau be contacted to assist the operator with the repeat sampling and any necessary water advisories.

If fecal coliform or *E.coli* are determined to be present in any routine or repeat sample, the supplier is <u>required</u> to notify the Water Bureau by the end of the day that the supplier was notified of the test result.

<u>Attachments:</u>
A map of the distribution system should be included with the sampling site plan, which identifies all routine and repeat sampling locations. It may also be beneficial to attach templates for common boil water advisories, so that the operator has them when needed.

Total Coliform-Positive Flowchart



3. Unreliable Samples

Water samples should always be collected carefully following applicable sampling instructions. Failure to do so could compromise the sample, causing unreliable results. Below are a few specific examples of sample types that are especially sensitive to collection procedures.

a. Bacteriological Sampling

The major cause of unreliable samples is excessive transit time, or the time between sample collection and analysis. It is the responsibility of the supplier of water to evaluate the variations in transit time and identify the obstacles. The sample holding time, method of transport, and transit time to a certified laboratory must be considered when collecting the sample. If there is any possibility that the sample may have been accidentally contaminated, then the sample should be discarded and a new sample should be collected. For instance, if a sample bottle appears to be dirty, the collection procedure was flawed, or a sample tap was compromised, then the problem should be resolved before the sample is collected.

b. Lead and Copper (Pb/Cu) Sampling

The concentrations of Pb/Cu in a water sample is greatly influenced by the sample collection procedures. Therefore, it is critical that samples be collected according to recommended procedures. The main source of unreliable Pb/Cu samples has to do with the age of the water being sampled. That is, the length of time the water has been stagnant in the site plumbing. Water that has been stagnant in the plumbing for an excessive time period may well yield unrepresentatively high results. Conversely, water that has just been extensively flushed and has had little contact time with the site plumbing may be unrepresentatively low. Since home owners are typically collecting the samples for the water supplier, it is in the water supplier's best interest to make certain samples were collected properly. Because a greater potential for sampling error exists with home owners collecting the samples, the water supply is strongly encouraged to sample early in the monitoring period to enable resampling or additional sampling should it be necessary. The following list summarizes Pb/Cu sampling recommendations assuming the water supply has already identified the proper sampling addresses based on the Tier 1-3 criteria:

- Select a fixture to sample from that is commonly used for consumption such as a kitchen or bathroom sink. Avoid infrequently used fixtures such as guest bathrooms and basement laundry sinks.
- When possible, avoid sampling at a vacant or seasonal home.
- Plan to collect the sample first thing in the morning.
- The night before you sample, run the cold water fixture you have selected for 3-4 minutes.
- Do not use water from this location again for 6 to 8 hours.
- In the morning before any water is used from the fixture, fill the sample bottle with the "first draw" of cold water.
- Fill out any paperwork provided with the bottle.
- When possible avoid sampling customers that have a point-of-use or point-of-entry treatment device.

The water supply is encouraged to provide the sampling participants with written instructions. If there is any suspicion that the sample was not collected properly, then the water supply is encouraged to discard the sample and resample.

c. Volatile Organic Compounds (VOCs)Sampling

Special care should be taken when collecting samples for VOCs.

- The sample must be collected in a small glass vial which usually has a special cap. The top of the cap has a hole sealed with a translucent plastic membrane which allows the laboratory to extract the sample. The vial should be filled slowly to the top so that the water level is at or above the rim. Then the cap should be carefully twisted on such that no air bubbles are in the vial. Although air will not hinder the lab's ability to analyze the sample, it may cause a VOC detection in the sample that is not representative of the water quality.

- Certain vapors in the air can also cause a detection of VOCs that is not representative of the water quality. Therefore, a VOC sample should not be collected if paint, solvent, fuel, or other vapors are present. It is recommended that the sample be collected from a well ventilated area.

4. General Monitoring Requirements at Entry Point to the Distribution System (EPTDS)

The next two tables summarize general compliance monitoring requirements. However, the compliance monitoring schedule for each supply is unique due to a variety of factors such as the type, age, susceptibility, and number of sources, type of treatment, previous detections, etc. Each public water supply receives a unique annual monitoring schedule early each calendar year, which summarizes specific samples required that year.

EPTDS Monitoring

	Groundwater Sources	**Surface Water Sources (including GWUDI)**
Partial Chemistry	1/year	quarterly – 1/year
Metals	every 3 – 9 years	every 3 – 9 years
Volatile Organic Compounds	quarterly – 1/3 years	quarterly – 1/year
Synthetic Organic Compounds (SOC)	quarterly – 1/3 years	quarterly – 1/3 years
Expanded SOC's Endothal, Diquat, Glyphosate, etc.	every 3 years for vulnerable aquifers, all others are waived	1 – 3 years for vulnerable sources, all others waived
Cyanide (unchlorinated systems)	every 3 – 9 years	not required
Radionuclides	quarterly – 1/9 years	quarterly – 1/9 years
Bromate	monthly for ozone systems	monthly for ozone plants
Chlorite	daily for chlorine dioxide systems	daily for chlorine dioxide plants
Chlorine Dioxide	daily for chlorine dioxide systems	daily for chlorine dioxide plants
TOC	not required	1 paired sample – monthly or quarterly for conventional plants
Nitrate	quarterly – 1/year	quarterly – 1/year
Nitrite	quarterly – 1/3 years	quarterly – 1/3 years
Fluoride	every 3 years	yearly
Sodium	every 3 years	yearly
Water Quality Parameters	per lead/copper rule	per lead/copper rule

5. General Monitoring Requirements within the Distribution System

Distribution System Monitoring

	Groundwater Sources	Surface Water Sources (including GWUDI)
Bacteriological	# based on population served	# based on population served
Chlorine/Chloramine residuals	same time and place as bacteriological sampling	same time and place as bacteriological sampling
TTHM & HAA5 – for systems serving chlorinated water	quarterly – 1/3 years	quarterly – 1/year
Lead and copper	every 6 months – 1/3 years	every 6 months – 1/3 years
Water Quality Parameters	per lead/copper rule	per lead/copper rule

Chlorine dioxide and chlorite samples must be collected at certain distribution system locations if the previous day or month chlorine dioxide/chlorite plant tap results are over the MCL or MRCL.

6. Required Turbidity Monitoring For Surface Water or GWUDI Treatment Plants (Subpart H plants)

Combined filter effluent – performed at least once every 4 hours at each CFE to ensure compliance with the turbidity standards. Frequency may be reduced to once per day for slow sand/alternative plants or for systems serving less than 500 people.

Individual filter effluent* – performed continuously (every 15 minutes) to asses filter performance.

*only applies to conventional and direct filtration plants.
* systems with 2 or less filters may conduct continuous monitoring of the CFE in place of individual filter effluent monitoring.

7. Cryptosporidium and *E. coli* Monitoring For Subpart H Plants

Schedule 1, 2 and 3 systems – must monitor the raw water source (before treatment) for cryptosporidium, *E. coli*, and turbidity at least once a month for 24 months.

Schedule 4 systems - must monitor the raw water source (before treatment) for *E. coli* bi-weekly for 12 months. If the *E. coli* trigger levels are exceeded, the system must conduct source water cryptosporidium monitoring twice a month for 12 months or monthly for 24 months.

8. Operational Monitoring for Complete Treatment Plants

Public water systems operating a complete treatment plant (including lime softening or lime-soda ash softening plants) should monitor for the following parameters in accordance with the frequency given in the Table below, in addition to those parameters with an MCL. Sampling of additional parameters may not be specifically required, but is necessary to ensure the treatment process is properly controlled. To demonstrate proper operation, treatment plant operators must fill out Monthly Operation Reports (MOR) reporting these operational parameters. A complete treatment system may also have to monitor for some of the parameters in the Limited Treatment Table, depending on the treatment employed.

Operational Monitoring For Complete Treatment Plants

Parameter	Location	Frequency	Comments
Turbidity	raw applied individual filter effluent combined filter effluent plant tap	every 4 hours during operation every 4 hours during operation continuous continuous or every 4 hours during operation continuous or every 4 hours during operation	Increase frequency when experiencing significant water quality changes Increase frequency when experiencing significant water quality changes Required every 15 minutes for conventional and direct filtration plants Sample location must be before storage. Grab samples are sufficient
Chlorine, Chloramines, CLO_2, residual	after each treatment process plant tap distribution system	hourly continuous daily	Locations dependent on feed points and C*T requirements (raw, applied, filtered) Required for Subpart H plants
Total organic carbon (TOC)	raw plant tap	monthly monthly	Required for Subpart H plants utilizing conventional treatment. Sampling frequency maybe reduced to quarterly.
Fluoride	raw plant tap dist. system	monthly daily weekly	Increased monitoring may be warranted for systems with elevated fluoride levels
Phosphate	plant tap distribution	daily weekly	
Ozone	contact chamber influent and effluent	continuous	Location depends on feed point.
Bromate	plant tap	monthly	Required for systems feeding ozone.
UV – intensity (254 nm)	inside wall of uv reactor	continuous	Continuous turbidity analysis may be necessary with high turbidity source water
Total coliform Bacteria	raw plant tap	daily daily	Resample and increase sampling Frequency when total coliform is detected.
Standard plate Count	raw & tap distribution system	daily monthly	
Total hardness	raw plant tap	daily daily	Every 4 hours if softening Every 4 hours if softening
Carbonate Hardness	raw plant tap	daily daily	Every 4 hours if softening Every 4 hours if softening
Chloride	raw plant tap	daily daily	
Alkalinity	raw intermediate plant tap	daily none daily	Every 2 hours if softening Every 2 hours if softening Every 2 hours if softening
pH	raw plant tap	daily daily	Certain treatment plants may have a need to increase ph monitoring frequencies and locations to properly control processes
Temperature	raw	daily	
Taste, odor & color	raw plant tap	daily daily	If taste, odor and color have not historically been an issue, the frequency can be reduced
Plankton enumeration & speciation	raw	as necessary	Dependent upon source location

Raw = water sampled directly from water source, upstream of any treatment.
Settled = water sampled directly following the settling process and prior to filtration
Plant tap = a point where treated water enters the distribution system after treatment and before the first customer
Combined filter effluent = filtered water effluent prior to the entry into a reservoir
Distribution = finished water sampled in the water distribution system.

9. Operational Monitoring For Limited Treatment Systems

Public water suppliers operating limited treatment systems should monitor in accordance with the Table below:

Operational Monitoring For Limited Treatment Systems

Treatment	Parameter	Location	Frequency	Comments
Chlorination	Free or total chlorine	plant tap dist. system	daily daily	
Chloramination	Total chlorine	plant tap dist. system	daily daily	
Fluoride	Fluoride	raw plant tap dist. system	monthly daily weekly	Increased monitoring may be warranted for systems with elevated fluoride levels
Corrosion control	Orthophosphate Or silica	plant tap dist. system	daily weekly	Test for orthophosphate or silica depends on which inhibitor product is used.
Potassium permanganate	$KmNO_4$ (visual)	plant tap	daily	A periodic visual inspection of water color at the filter influent is appropriate to control feed rates for iron/manganese removal.
Iron sequestration	Polyphosphate	distribution	weekly	Digestion method for phosphorous should be used unless feeding a ortho/poly blend
Iron removal	Iron	raw plant tap	monthly daily	
Central ion-exchange softening	Hardness Iron Sodium Langelier index	raw & plant tap raw & plant tap plant tap plant tap	daily daily monthly monthly	Iron should be tested for if raw iron exceeds 0.3 mg/l; Langelier index is recommended to determine if the treated water is aggressive.
Nitrate removal	Nitrate Chloride	raw & plant tap plant tap	daily monthly	
Arsenic removal	Arsenic	raw individual filter plant tap	monthly weekly monthly or quarterly	Refer to the arsenic policy WB-03-020

Plant tap samples must be collected while the well pump is running to get the most accurate indication of the chemical concentration being added to the system. Plant tap analytical measurements should be compared to dosage calculations on a daily basis to ensure proper chemical feed rates. In addition, samples should be sent to a lab periodically to compare the results of the field test kits to ensure the test kit is accurate. Operational monitoring should be done in accordance with EPA approved methods. The certified operator in charge is responsible for reviewing the operational data, making necessary treatment adjustments, and making the Water Bureau aware of any treatment problems. Additional operational monitoring and reporting may be necessary. Treatment plant operators must accurately complete monthly operation reports on a form approved by the Water Bureau.

10. Monitoring Requirements for Standby Wells

Reduced monitoring requirements may be established for any well or wellfield reserved for standby use if it is not needed to comply with the firm pumping capacity requirements for the system and is not automatically activated by system controls. Due to the variability of standby well operation, the water quality, and the susceptibility to contamination, the monitoring requirements for each well will be determined on a case by case basis by the Water Bureau district staff. Generally, a well that is not routinely monitored will not be allowed to be placed into service.

11. Reporting Monitoring Data

A supplier of water employing a treatment system must submit monitoring data within 10 days of the month following the month of record. Monitoring data other than what is routinely reported on the monthly operation reports may be included in the monthly operation reports or submitted with the monthly operation reports. Monthly operation reports must be prepared, signed, and submitted to the Water Bureau by the 10th of the month following the month of record.

A narrative description of significant water system operation events should be provided in the remarks section of the MOR. Abnormal water use such as hydrant flushing, fire events, water main breaks, or tank overflows should be reported as well as chemical feed problems, water quality anomalies, process interruptions or significant customer complaints.

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PART 8 GROUNDWATER SOURCES

Applicable references

- Michigan Safe Drinking Water Act, Part 8
- Michigan Water Well Construction and Pump Installation Code
- DEQ- Water Bureau Policies, DWRP-03-016, *Grouting of Community Water Supply Wells* and WD-03-003, *Aquifer Test Requirements For Public Water Supply Wells*
- Recommended Standards For Water Works, Part 3.2

1. Purpose

Most public water supplies in Michigan use groundwater as their source for drinking water. Groundwater is generally available, requires little or no treatment, and can be very economical. It is important to take precautions in the location and construction of wells for public water supplies. By following minimum standards, this often allows the owner of a public water supply to provide a safe, reliable and adequate quantity of water meeting the state drinking water standards for public use.

2. Minimum Standards

Minimum standards and requirements for construction and location of groundwater sources are those which have been demonstrated by experience to be essential to safeguard a public water supply. These standards and requirements include a sufficient safety factor to allow for unknown or unforeseen factors in the design of the system.

3. Deviations from Minimum Standards

Deviations from the minimum standards prescribed by this part may be approved by the Water Bureau, usually as a condition of the permit. An owner of a public water supply will have to demonstrate to the Water Bureau that the deviation will not adversely affect the public health, such as:

a. Extensive protective geological formations of impervious clay.

b. Horizontal distances in excess of the standard which can be permanently controlled by the owner in the future.

c. Hydrogeological studies.

d. Pumping rates relative to the aquifer capacity.

e. Drawdown and pump intake submergence.

4. Significant Changes or Major Repair Requirements

Changes or major repairs to an existing well require a construction permit from the Water Bureau. In addition to the examples listed in Part 8 of Act 399, the following situations constitute a significant change or major repair:

a. Replacing a well screen with one of changed design that increases or decreases the pumping capacity, or one of different materials or construction (type of metal, plastic, etc.).

b. Changing the elevation and/or design of the termination of the top of the well casing.

c. A change in the design and protection of any suction lines.

d. Changing the gravel pack in a well with a material of different specifications.

e. Grouting the well casing where necessary.

A significant change or major repair shall not include routine maintenance or incidental repairs, such as: lubrication of the pump; changing packing or gaskets; cleaning the pump impellers and well casing; normal redevelopment of a well where the gradation of materials is changed only within five feet of the well screen; replacement of a pump or motor with an equivalent unit.

5. Treatment

Simple chlorination of a public water supply is not acceptable in lieu of required isolation and construction of a new well. The Water Bureau has historically not allowed wells drilled in bacteriologically contaminated groundwater aquifers to remain in service with chorination Also, the Surface Water Treatment Rule specifies treatment techniques for groundwater under the direct influence of surface water. Chlorination of other groundwater sources not subject to the above rules may be required or recommended by the Water Bureau under certain circumstances. Examples of situations where chlorination of a ground water supply may be required include existing wells with construction or isolation deficiencies, use of other chemical treatments such as phosphates, confirmed problems with bacteriological growth in the distribution system, systems utilizing gravity filtration, and introduction of air for oxidation or odor removal. The more likely the hazard of contamination of the well field or of a certain well, the more extensive the treatment will be required. The supplier of water shall obtain written approval from the Water Bureau before utilizing a well or well field not in compliance with this part.

6. Deviations in Construction and Location

A supplier of water employing a complete treatment system, including sedimentation (possibly lime softening), filtration and chlorination with enough contact time to provide 4-log inactivation of viruses may receive special consideration by the Water Bureau as to the location and construction of wells and the ownership of isolation areas of wells used as a raw water source. Where the requirements in this part of the rules are not met, a raw water bypass around the treatment plant or any treatment process cannot be permitted.

7. Size of System - Classification

Design requirements or criteria for the various types of public water supplies are based on the type and number of facilities they are intended to serve and the volume of water used by these facilities. Changes in these factors may cause a change in classification of a water supply (see Part 5 – Types of Public Water Supplies) and the resulting requirements applicable to the new classification, must be met by the supplier of water. Examples are increased uses due to new subdivisions, additional housing, industries, commercial establishments, increases in use by established users, or expansion of migrant labor camps, manufactured housing parks, food handling establishments, schools, state and location institutions, health care facilities, etc.

The initial design or expansion of an existing system must take into consideration future development and uses of water. The components of the water supply system (wells, storage tanks, booster stations, etc.) should be sized and constructed to satisfy the foreseeable future (up to 20 years) and be designed to accommodate expansion for the total development to meet the requirements for the ultimate type of system. It is important to note that certain construction and isolation requirements for Type I wells are more stringent than for Type II or Type III wells, and that it may be difficult, costly or even impossible to convert Type II or Type III wells into Type I at a later date.

8. Well Location

In order to demonstrate adequate control and protection of a well site and the surrounding isolation area, the steps below shall be followed:

a. The location of the well for a Type I water supply shall be approved by the Water Bureau in writing prior to construction.

b. Ownership or legal control of the standard isolation area for the well is required to be submitted in writing.

c. The intended capacity of a well or well field should be designed to adequately satisfy maximum day demands if gravity storage is provided, or peak instantaneous demands if only hydropneumatic storage exists.

d. The well shall be constructed to maintain existing natural protection against contamination of the aquifer.
    i) Retain natural contours or use grading to protect the well from surface drainage.
    ii) Prevent unnecessary trenching and filling of the site.
    iii) Grouting with neat cement shall be used to seal the natural ground formation to the well casing. See Item No. 20 for additional information.

9. Construction of Wells

Construction of wells, including but not limited to: casing materials and dimensions, types of joints, must comply with the *Michigan Water Well Construction And Pump Installation Code*.

10. Modification of Standard Isolation Area

Any new or replacement well should be located in areas with adequate isolation distances. Any modifications to the standard isolation area of a well made by the Water Bureau shall be in writing and be based upon hydrogeological conditions such as:

a. The proposed depth of well.

b. The types of materials which overlie the aquifer and an evaluation of their imperviousness and areal extent.

c. The submergence of the screen during the maximum pumping rate.

d. The porosity and transmissivity of the water bearing formation.

e. The direction of flow of the groundwater, both under static and pumping conditions and the effect of other wells in the area.

f. Daily pumpage rate or extraction rate.

11. Ownership of Isolation Area

Experience has shown that ownership of the standard well isolation area is the most positive way to exclude sources of contamination and to prevent activities near wells which may lead to accidental contamination. Even when owned, the isolation area must be protected from other potentially harmful uses. Where a long-term lease or easement is permitted instead of ownership, a written legal agreement is necessary between the two parties, a copy of which is to be supplied to the Water Bureau for approval. Any changes in these agreements must be approved in advance by the Water Bureau.

Local ordinances are unsuitable and unacceptable for meeting the requirements for ownership and control.

12. Filter Backwash Water Discharge Piping Within Well Isolation Areas

Many treatment plants are situated near one or more of the supply wells. This presents a potential concern with maintaining the well isolation area due to sanitary sewer connections for disposing of filter backwash water. In well isolation areas, installation of filter backwash discharge lines should be avoided due to the potential for sewage to backup and compromise the well isolation.

For some projects, it is not possible to avoid installing the backwash water discharge piping in the well isolation area. In these situations, the design of the discharge line must include an acceptable means of preventing sewage (sanitary or storm) from backing up into the backwash pipe.

The available isolation area must be maximized by locating the treatment plant and filters as far away from the wells as possible. Many projects have utilized site grading to in such a manner that eliminates the chance of sewage from backing up the discharge line into the isolation area. In these cases, the elevation of the backwash line is demonstrated to be higher than the flood level of adjacent manholes. The design assures that any sewage back up is outside of the well isolation area.

The connection to the sanitary sewer is often accomplished using a properly designed air gap. In certain situations, a drop connection at sanitary sewer manhole which is located outside of the isolation area is acceptable. Although drop connections are not properly designed air gaps for cross connection protection, they do minimize the possibility of sewage from entering the backwash line and encroaching upon the isolation area.

It may be possible to use an approved backflow prevention device that is installed outside of the well isolation area. Other designs have included a backwash holding tank with an air gap located outside of the well isolation area or installing pinch valves in adequate locations to prevent sewage from entering the backwash line.

If the treatment plant has restroom facilities, a similar design strategy needs to be used to protect the well isolation area. The sanitary connection from restrooms shall be a separate connection from the filter backwash line.

13. Isolation Distance – Major Sources of Contamination

Act 399 states that all wells must be located 2,000 feet from major sources of contamination. However, since public water systems are only required to own or control the standard isolation area, this 2,000 foot distance usually only applies to locating new wells during the well site inspection process. Approval to install a new well within 2,000 feet of a major source of contamination must be in writing from the Water Bureau and shall be based on an assessment of the potential for groundwater contamination. The following factors should be included in the assessment:

a. Location of the major source of contamination in relationship to 10-year capture zone of the well.

b. Groundwater flow direction and gradient.

c. Chemical and physical properties of stored chemicals: physical state, solubility, concentration, toxicity, specific gravity, viscosity.

d. Design of chemical storage facilities.

    1. Maximum storage volume and unit volume of storage (50 lb. bags, 55 gallon drums, etc.).

    2. Construction materials for storage buildings, floors, and storage tanks (steel, concrete, earth, etc.).

    3. Special safety devices (pressure relief, overflow pipes, alarms, pressure testing equipment).

    4. Corrosion protection.

    5. Materials transfer procedures.

6. Containment (including materials, curbing or diking, drainage systems, spill control equipment).

7. Security systems (vandalism, sabotage).

8. Location (below grade, finish grade, or elevated, high volume traffic areas, loading/unloading areas and procedures).

14. Hydrogeological Conditions

A study of hydrogeological conditions shall be prepared by the supplier of water of a Type I water supply if any single well capacity is equal to or greater than 70 gpm. The study shall be provided to the Water Bureau for a determination on the isolation area and the acceptability of the location of a well. This may include information as follows from existing wells or test wells:

a. Previous hydrogeological studies.

b. Site visit to location.

c. Aquifer test in accordance with the *Aquifer Test Requirements For Public Water Supply Wells* policy.

d. Water quality analyses.

e. Existing well logs and abandoned well logs.

15. Flooding

When a well is located in an area where surface water flooding occurs (but not within 25 feet of the well), special provisions are needed to provide access at all times. This could include an access roadway above the flood stage. If an access roadway is not provided, the system must be capable of meeting the firm capacity requirements without the well in question being available.

16. Changes in Grade with Respect to Flooding

The water supplier cannot change or permit changes in the grade of roads, streams, or other structures which could cause flooding of the area within 25 feet of the well.

17. Cavernous Rock

Fractured, fissured, jointed, cavernous or porous rock provides little or no filtering and no resistance to flow, both of which are important to protect groundwater from contamination. Proper well drilling techniques are critical and must be used. The hydrogeologic study should pay special attention to the use of rock formations by others for disposal of storm water, septic tank effluents, sanitary and storm sewers, barnyard wastes, basement drains, sanitary landfills, and similar practices in the area.

18. Nonferrous Casing

Where nonferrous casing materials are to be considered, including radial and other collectors, approval must be obtained from the Water Bureau. Nonferrous material proposed as a well casing must be resistant to the corrosiveness of the water and soil and to the stress to which it will be subjected during installation, grouting and operation.

19. Drawdown Seals

Drawdown seals are mechanical devices occasionally installed in water wells. They provide an airtight seal between the submersible pump drop pipe and the well casing and are designed to reduce the lowering of the static water level within the well casing during pumping. When the pump is running, a low pressure or vacuum is created below the seal. These seals are also marketed as pollution barriers; to eliminate aeration and control iron precipitation; to increase well efficiency and yield; to protect submersible pumps from running dry; and to center the pump.

Drawdown seals may be acceptable if they are installed 25 feet below the established ground surface (except as noted in the following paragraph), as close to the pump intake as possible, but at least 5 feet above the screen. Bentonite grout or other sealing materials should not be placed on top of a drawdown seal. They must not impart taste, odor, toxic substances, bacterial or chemical contamination to the well water.

Single or multiple drawdown seals may be installed within 25 feet of the ground surface, if used to stop or control the discharge within a flowing artesian well.

The installation of a drawdown seal must be noted on the Water Well and Pump Record and the reason for its use should be stated.

20. Grouting

All new type I wells must be grouted with neat cement the entire length of the casing to give added protection to the well from the entrance of surface water or near surface contaminants and to protect the well casing from corrosion. Other methods and materials may be used if approved in writing from the Water Bureau prior to the drilling of the well. See *Grouting of Community Water Supply Wells* policy in Appendix A for further information.

21. Pitless Adaptors

A list of approved pitless adaptors is maintained by the Water Bureau and is available on the DEQ website under Drinking Water/Water Well Construction. Approval of specific applications of pitless units by the Water Bureau is by issuance of a construction permit. In addition to the guidelines in Part 3 of Recommended Standards for Water Works, pitless units shall:

a. Be threaded, welded to the well casing, or approved pressurized, clamp-on units. Clamp-on units are not recommended for large capacity wells (greater than approximately 50 gpm).

b. Terminate at least 12 inches above the established ground surface or 2 feet above highest known flood elevation or the one hundred year flood elevation, whichever is higher.

22. Weld-on Pitless Adaptors

Any weld-on pitless unit must be designed such that all field welding can be done in either a horizontal or downward position of the welding rod. No overhead welding is permitted on field installations.

23. Drawdown to Screen

It is essential to design and construct a well to prevent drawing down the water in a well to or near the well screen or the tailpipe (pump inlet or intake) in order to prevent:

a. drawing contaminants into the well;

b. the depositing of chemicals or scale which may plug the well screen; or

c. drawing air into the pump, thence to the distribution system.

Calculations for well screen capacity should be provided as part of the well permit application.

24. Sampling Tap

A proper sampling tap is normally quarter inch diameter or less, with smooth tubing, non-threaded, contains no screens or filters, points downward, has a leak proof housing, provides a representative sample for testing, and is located to facilitate sample collection in a sanitary manner. All sampling taps should be located at least 12 inches above the floor, above the potential flood elevation and with the waste flow directed to an acceptable drain or disposable point. Sampling taps should be provided both for raw well water and for treated water, even if the system does not normally provide treatment.

25. Metering

A means to measure the volume of water produced from each well is required. Depending on the rate of pumping, various metering devices may be used. The type and size of meter selected should be based on the average and range (minimum to maximum volume) of water being pumped. A measurement of the electrical energy consumed over a certain period of time does not relate directly to the volume of water being pumped and therefore should not be used for flow measurement; however tracking electrical usage or run times is useful for operational purposes and is therefore recommended in addition to flow metering. Totalizing meters are encouraged

26. Line Shaft Turbine Pumps

Line shaft turbine pumps should be provided with a means to protect against damage due to backspin. Either a suitable time delay mechanism or a backspin ratchet should be incorporated into the pump design.

27. Prelubrication

An appropriate means should be provided when necessary for prelubrication of bearings in line shaft pumps.

28. Test Pumping – High capacity wells

High capacity wells, defined as 70 gallons per minute or greater must undergo an aquifer test in accordance with the *Aquifer Test Requirements For Public Water Supply Wells* policy unless waived by the Water Bureau. Wells serving Type I public water supplies are required to undergo performance testing to verify the proposed pumping capacity of the well. The well shall be tested after it has been constructed, developed, cleaned and the depth accurately measured.

29. Test Pumping – Wells Less than 70 gpm

Each Type I well constructed to provide less than 70 gpm should be tested for yield and drawdown. The basic acceptable procedure will include the following:

a. Be performed on every production well after construction, following disinfection and prior to the installation of the permanent pump.

b. Test pump the well at it's maximum anticipated rate for at least 4 hours or until the drawdown stabilizes.

c. Record the following data:
    i) test pump capacity
    ii) static water level(s)
    iii) depth of test pump settings
    iv) time of starting and ending each test cycle

d. Provide the following information at the time intervals as required in policy *Aquifer Test Requirements for Public Water Supply Wells*:
    i) pumping rate
    ii) pumping water level
    iii) drawdown
    iv) water recovery rate and levels

e. If interference from other nearby wells is a concern, water levels reading from those nearby wells should also be collected during the pump test.

30. Step Pumping Tests

Description: A short term test at two or three different pumping rates. Pump tests used primarily when a nearby observation well is not available.

a. Purpose: To evaluate the pumped well; in new wells to determine screen losses (turbulent flow losses near the screen); progress made in the well development and assist in determining well efficiency. In older wells step tests can determine when a well screen needs redevelopment and the effectiveness of redevelopment procedures.

b. Pumping Rates: The first step should be at approximately half of the maximum rate. The maximum rate should be selected as to not break suction at the end of the test. Exact pumping rates are not as important as establishing a step rate quickly and then maintaining that rate consistently during the pumping step.

c. Readings: Water level readings should be made as accurately as possible using an electronic water level tape or equivalent method. Air lines should only be used when drawdowns exceed 30 feet or no other method is feasible.

d. Rest Period: Two hours with readings every 30 minutes and the last reading just prior to starting the pump.

e. First Step: Pump at approximately half the maximum rating for one to three hours and take water level readings:

    i) every 5 minutes for 30 minutes
    ii) every 10 minutes for the next 30 minutes
    iii) every 15 minutes for the remainder of the test.

f. Second Step: Pump at rate approximately double the first step and for the same time period. Take readings at same schedule as first step.

g. Recovery Readings: None are required.

h. Shutdowns: Breakdowns of up to 10 minutes are tolerated. Report exact time of breakdown and restart.

i. Disposal of Water: Discharge away from well to be certain water will not recharge the well.

j. Type of Water Bearing Formation: These step tests procedures apply to either artesian or water table conditions (all wells).

31. Disinfection of Flowing Wells

A chlorine solution should be applied for one hour at or below the formation producing the artesian condition. The chlorine solution applied must be of sufficient concentration to provide 50 mg/L in the flowing water.

32. Disposal of Chlorinated Solution

Caution must be exercised in disposing of spent solutions of chlorine from any water works facility (wells, storage tanks, water mains, etc.) as to not harm vegetation or wildlife, nor upset any sewerage system. Water additives such as chlorine shall not be discharged to a surface water body, sewer, or drain. Dechlorination equipment shall be used prior to discharge if detectable levels of chlorine from disinfection are present in the discharge. If water will reach a surface water body and certain provisions cannot be met, a NPDES permit is required. A general NPDES permit (MIG640000) is available for waste water discharge from a potable water supply.

33. Type I Well Permit Process

The general process for obtaining a construction permit for a Type I well is as follows:

a. Submit a site plan with all the required information to the appropriate DEQ District Office.

b. DEQ Water Bureau staff will conduct a well site inspection.

c. If applicable, Water Bureau staff will give written permission to the owner to conduct test well drilling. No wells, including monitoring wells, are to be drilled without permission. The letter will state any special conditions or requirements that need to be addressed, such as water sampling instructions or special construction features. Draft well specifications should be submitted before the construction of a test well that will be converted to a production well to verify the test/production well will be constructed in accordance with Type I standards.

d. Perform a pump test in accordance with No. 28 or No. 29 of this part and submit the final report to the Water Bureau for verification.

e. Submit a well log, water sample results, well construction details, pump and motor specifications, and any other requested information.

f. If the above items are acceptable to the review engineer, a construction permit will be issued to the owner to convert the test well to a production well.

34. Wells Funded By the Drinking Water Revolving Fund (DWRF)

Any new well funded by the DWRF must obtain certain environmental clearances prior to starting the construction of the well. Failure to do so may render the project ineligible for DWRF funding. Water system owners are expected to obtain the required clearances before constructing <u>any</u> water works facility funded by the DWRF.

35. Water Withdrawal Requirements

Current water withdrawal rules require the Water Bureau to evaluate any Type I water system owned by a political subdivision for any new or increased cumulative capacity >2 MGD from any ground water source after March 2006. The rules also allow the Water Bureau to reject plans and specifications for a new source on the basis of an Adverse Resource Impact.

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PART 9 SURFACE WATER SOURCES

Applicable references

- Michigan Safe Drinking Water Act, Part 9
- Recommended Standards For Water Works, Part 3
- Part 327 of Public Act 451 of 1994, Natural Resources and Environmental Protection Act, Great Lakes Preservation

1. General

The largest quantity of water produced by public water supplies in Michigan originates from surface water sources because of the abundance of high quality raw water, especially from the Great Lakes and connecting waterways. Certain precautions are important in the location and construction of surface water intakes because water quality varies considerably due to both natural and man-made conditions. Water quality variations will relate to the degree and type of treatment necessary to produce safe water and meet the state drinking water standards.

2. Minimum Standards

Minimum standards and requirements are those which have been demonstrated by experience to both safeguard a public water supply and include a sufficient safety factor to allow for unknown or unforeseen factors in the design or operation of the facility.

Deviations from the minimum standards may sometimes be permitted where an adequate safety factor can be attained and demonstrated. This includes such factors as: exceptionally long distances from shorelines and sources of contamination, depth of water over intake or other features to protect the source from icing and currents carrying contaminants.

Approval of a surface water source includes review of all tributary streams and drainage basins, natural lakes, and artificial reservoirs or impoundments above the point of a water supply intake.

3. Deviations

Any deviations from the minimum standards must not adversely affect the public health. Data must be submitted to the Water Bureau along with reasons why any deviations should be considered prior to possible approval.

4. Water Quality Report

To evaluate the appropriateness of a proposed surface water source, it may be necessary to gather information through a water quality report. It is important that the owner of the supply and the Water Bureau establish in advance the probable scope of the report as the work may extend over a long enough period of time to ascertain seasonable variation in water quality parameters, including quality and quantity. Such factors must also be interpreted in the context of possible variations from year to year.

5. Shore Well Requirements

The intake pipeline for Type I water supplies shall terminate in a shore well, water treatment plant or other structure which should:

a. Be equipped with removable or traveling screens before the pump suction well. The need for traveling screens will depend on the size of the intake and type of material anticipated to enter the intake, such as fish and debris. Standby screens of either removable or traveling variety should be provided to permit continuous operation of the treatment plant.

b. Have provisions for withstanding surges, especially where direct pumping from the intake line is practiced.

6. Intake Design – General

Flow in the intake pipeline should be induced by the difference in elevation between the water levels at the entrance to the intake and in the shore well. Designs for negative pressure in the intake pipeline are discouraged. Direct pumping from the intake pipeline should not be practiced for Type I public water supplies.

The presence of an emergency intake is strongly recommended. The construction of a redundant intake pipeline for emergency is preferred, although a T or Y inlet on the primary pipeline is acceptable.

7. Materials

Specifying classes and types of materials in accordance with appropriate AWWA standards used for intake pipelines, joints, and intake inlets should be based on area conditions and experience, with review by the Water Bureau before final selections are made.

8. Intake Pipeline Protection

The intake inlet and pipeline shall be designed, located, and constructed to provide adequate protection against rupture by timbers, logs, and sand, sabotage and malicious acts, rapid deterioration in water quality (applicable to river/current deterioration), silt infiltration or plugging.

A list should be maintained of reliable contractors for urgent repairs or cleaning of the intake for implementation in the event of an emergency.

9. Provisions for Cleaning

Provisions should be made to permit occasional cleaning of the inlet line. This may be done by providing accessible T or Y sections in the line for the introduction of cleaning equipment or by backflushing the line. The latter may become important in removing frazil ice from the intake line and inlet when no other means is available. Where back flushing with treated water is employed, appropriate cross connection control is necessary. When discharging treated water to the surface water source, an appropriate NPDES permit must be obtained.

10. Pressure Testing and Intake Integrity

In order to ascertain the structural integrity of intake lines, visual diver inspections and pressure tests are recommended. Pressure tests in accordance with appropriate AWWA standards should be performed in a similar manner as those performed on water distribution systems. Intakes should be professional inspected at least once every 5 years.

11. Hydraulic Determination

The Hazen-Williams “C” value or other friction factor for the pipeline should be determined after placing the intake into operation, and thereafter at periodic intervals. This can give an indication of growths on the inside of the intake pipe, obstructions, or joint leakage, as well as the impact of internal piping, such as a chlorine injection line.

12. Water Withdrawal Requirements

Current water withdrawal rules require the Water Bureau to evaluate any Type I water system owned by a political subdivision for any new or increased cumulative capacity >5 MGD from the Great Lakes or connecting waters after March 2006. The rules also allow the Water Bureau to reject plans and specifications for a new source on the basis of an Adverse Resource Impact.

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PART 10 TREATMENT SYSTEMS AND PUMPING FACILITIES

Applicable references

- Michigan Safe Drinking Water Act, Parts 3, 6, 10 and 12
- DEQ-Water Bureau Policies, WD-03-018, *Turbidity Compliance Monitoring and Determination of Compliance With The Turbidity Treatment Technique Standard*, WD-03-020, *Design and Operational Requirements For Arsenic Removal Treatment Systems For Compliance With The Arsenic MCL* and WB-012, *Disposal of Backwash Water From Arsenic Removal Units*
- Recommended Standards For Water Works,
  - Parts 4, 5, 6 and 9;
  - *Interim Standard On Membrane Technologies for Public Water Supplies*
  - *Interim Standard - Nitrate Removal Using Sulfate Selective Anion Exchange Resin*
  - *Policy Statement on Arsenic Removal*
  - *Policy Statement On Ultra Violet Light for Treatment of Public Water Supplies*

- AWWA Manuals
  M4, Water Fluoridation Principles and Practices
  M20, Water Chlorination Principles and Practices
  M30, Precoat Filtration
  M37, Operational Control of Coagulation and Filtration Processes.

Additional AWWA and U.S. EPA publications are available for specialized treatment systems (nitrate, radionuclide, and arsenic removal).

1. Applicability

Surface water treatment plants, ground water treatment systems, chemical feed installations, pumping capacity, pump station design

2. Definitions

Subpart H System – A water system using a surface water source, or a ground water source under the direct influence of surface water (so named because these sources must comply with the treatment requirements of Subpart H of the Federal Safe Drinking Water Act).

3. Treatments Systems

   a. Treatment Units

   For Subpart H systems, a minimum of two units each for rapid mix, flocculation, sedimentation (if used), filtration, and disinfection shall be provided. Each unit shall be constructed to allow it to be removed from service without interrupting the operation of the remaining units. The design should consider the hydraulic effect (entrance and exit flow patterns and short-circuiting) on the remaining units when a unit is removed from service.

b. Treatment Optimization

Surface water treatment plants are encouraged to review and implement the recommendations in the May 16, 1995 memorandum titled *Recommended Practices for Treatment Optimization*. The memorandum lists a number of voluntary guidelines for surface water treatment plant design, operation, and monitoring. A copy of the memorandum and May 23, 1995 cover letter from the Michigan Department of Public Health (now MDEQ) is found in Appendix B.

c. Plant Waste Disposal

Although the recycling of certain plant wastes (spent filter backwash, thickener supernatant, and liquids from dewatering processes) is permissible under the U.S. EPA's Filter Backwash Recycling Rule, recycling should be considered only when other methods of treatment/disposal are not feasible. Guidelines for the design of various types of waste disposal facilities are contained in Recommended Standards for Water Works. Additional requirements for discharges of wastes to surface or ground water are contained in Part 31 (surface water) and Part 22 (ground water) of the Michigan Natural Resources and Environmental Protection Act, Act 451. Where necessary, NPDES or groundwater discharge permits shall be obtained

d. Chemical Handling

The Water Bureau review process will include a critical review of the safety hazards of storage, transport and handling of chemicals. When two or more chemicals are available for the same purpose, the use of the less hazardous chemical should be strongly considered, especially if it results in improved operator safety and reduced regulatory burden.

e. Chemical Bulk Storage Tanks

Appropriate security measures such as fencing, gates, and/or locked/labeled exterior fill lines shall be provided for bulk chemical storage tanks. A sump area or other suitable containment shall be provided beneath bulk chemical tank fill lines. When designing exterior walls and locating piping, electrical systems, etc., consideration should be given to the future removal/replacement of bulk storage tanks.

f. Chemical Day Tanks

As indicated in Recommended Standards for Water Works, day tanks shall be provided where bulk chemical storage is utilized. Other proprietary designs, for example Roto-Dip feeders, which function as a feeder/day tank combination, may be approved for larger water systems that are equipped with adequate safeguards to prevent overfeeds. Containment should be provided for all day tanks.

In some small water systems, due to the relatively small volume of chemical fed each day, no day tank is used, and the chemical is fed directly from a shipping container. A means for measuring the amount of chemical fed must still be provided. For systems where very low volumes of chemical are fed, it may be necessary to dilute the chemical with water and increase the feed rate in order to accurately measure the volume of chemical being fed on a daily basis and to result in a more uniform chemical feed rate.

4. Membrane Filtration

The use of membranes for the treatment of both surface and ground water sources is becoming increasingly popular. Low pressure membranes can be used to remove viruses, bacteria (e-coli), protozoa (giardia) and cysts (cryptosporidium) from surface water sources. Inorganics, dissolved metals and radionuclides can be removed from ground water sources using high pressure membranes. Membranes are typically classified as microfiltration, ultrafiltration, nanofiltration and reverse osmosis. The pore size of the membranes decreases and removal efficiency increases from the microfiltration to each subsequent classification.

If membranes are being considered as part of an overall treatment process, the guidelines stated in the *Interim Standard on Membrane Technologies for Public Water Supplies* of Recommended Standards For Water Works, 2007 Edition should be followed. Also, the U.S. EPA *Membrane Filtration Guidance Manual* is a valuable reference that should also be consulted when considering membranes for drinking water treatment.

Unless otherwise directed by the Water Bureau, it is a requirement that membrane treatment plants be piloted to demonstrate that the proposed water treatment will meet the treatment objectives plus the capacity and regulatory requirements using the site specific source water. Pilot plant studies should be conducted in accordance with the suggested practices provided below.

a. Pilot Testing

The primary goal of a membrane pilot study is to obtain information such as treated water quality and operating parameters that are necessary for the design of a full scale membrane plant. Below is a list of items that need to be completed prior to, during and after a pilot test is performed.

1. <u>Water Quality Review</u> – A water quality review of the existing source water quality shall be performed to determine if membranes are feasible for a particular source of water and if pretreatment is necessary. If membranes are being used to comply with the requirement of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), the membranes must be challenge tested to establish Cryptosporidium log removal efficiencies. Examples of water quality parameters to measure prior to piloting are listed in Table 6.1 of the *Membrane Filtration Guidance Manual*. Others parameters to consider are water temperature variations, organics, inorganics, disinfection byproducts, particle counts plus bacteria, virus and cyst concentrations.

2. <u>Pilot Testing Study Plan</u> – This plan should be developed and submitted to the Water Bureau for approval prior to conducting the pilot study. Study plan objectives should be well defined and should clearly identify the specific questions to be answered by the study. The pilot should be designed to represent the range of operational scenarios for the specific proposed treatment plant. The data

collection should be planned to provide clear answers to the questions identified in the study plan. The plan should provide a means to answer questions regarding flux rates for both cold and warm water, backwash and chemical cleaning products/frequencies, system recovery, operating and transmembrane pressures, pre- and post-treatment requirements, bypass ratios, amount and quality of reject water, removal efficiencies, fouling potential plus power consumption. All of these items will ultimately be needed to properly design a full scale membrane plant.

3. Pilot Plant Design - The pilot plant should use raw water from the specific source proposed for treatment. If applicable, the raw water used should receive pretreatment as proposed for the full-scale plant. The pilot plant should include the same membrane material, membrane geometry, membrane thickness, packing density, array and stages as in the proposed full-scale plant.

   The pilot plant should be operated under the range of conditions expected for the full-scale plant. These conditions may include varying temperature, pressure, flow rate, raw water quality, pre and post treatment, chemical feed, backwashing and cleaning. It is recommended to conduct the pilot study for sufficient duration to include at least two clean-in-place cycles. For surface water sources, the pilot study length must include the coldest and warmest expected water temperature and operate for least 6 months, preferably for 9 – 12 months.

4. Data Collection – This effort should be sufficient to quantify all important aspects of system performance as it relates to meeting the objectives, including operational parameters, water quality, microbial monitoring (if applicable) and integrity testing.

   Operational parameters that should be monitored continuously include elapsed run time plus the pressure, flow and temperature of the feed, filtrate and concentrate flows. Information associated with intermittent processes such as backwashing and chemical cleaning must be measured. Air, water and chemical usage must be documented.

   Water Quality monitoring is needed to characterize the source water, product water, product water stability, residuals, the effect of pre- and post-treatment, membrane removal efficiency, membrane integrity, membrane fouling, and the effects of operations like pretreatment filter breakthrough and backwashing and chemical cleaning. For membrane systems following an iron removal process, extra attention needs to be given to the effectiveness of the iron removal process to make certain that iron breakthrough does not occur that can dramatically impact the membranes. If taste or odors are a possible concern, they should also be addressed within the study.

   Sampling locations should allow for quantification of all influent, effluent and waste flows plus allow for quantification of important intermediate processes where applicable. Sampling frequency should be sufficient to account for the variability of the constituents being sampled, and sampling should be conducted throughout the range of operating scenarios. Examples of water quality parameters to measure during pilot testing are listed in Table 6.2 of the *Membrane Filtration Guidance Manual*. Backwash water flow should be checked weekly for total suspended solids (TSS) and turbidity.

Samples need to be preserved and analyzed according to approved procedures. Meters and probes need to be properly calibrated according to the manufactures recommendations.

If membranes are being installed for LT2ESWTR compliance, the direct integrity test protocol intended for a full-scale plant should be included in the pilot unit at a frequency agreed upon between all parties.

5. Data Analyses - Based on analyses of the collected data, the pilot study should determine the membrane flux rate as a function of pressure throughout the range of expected operational scenarios. Analyses should determine the removal efficiency for important constituents, and the concentration and mass of important residuals. The analyses should also determine the effects of proposed chemical feed and pretreatment options, the membrane fouling rates, the frequency of backwashing and cleaning, and expected energy requirements. The pilot study should confirm the proposed log removals for expected operating conditions.

6. Study Report - The study report should clearly describe what actually took place during the pilot study and summarize all procedures and test results. The report should contain all information gathered during the pilot to establish design parameters for a full scale plant. Operational parameters for each filter run between chemical cleanings must be summarized. A complete list of all samples, including sample location, date, and time of collection should be provided. Conclusions, recommendations, and design variables (flux, backwashing, chemical cleaning, residual disposal, etc.,) should be discussed and based on measured results. The study report should be submitted to the Water Bureau for review prior to plant design.

b. Design Requirements For a Full Scale Plant

The design phase of a membrane plant must take into consideration many factors. Data obtained from pilot testing or other membrane plants using a similar source of water must be used in the design process. Below are several items that must be included in a full scale membrane plant design.

1. Membranes – The membrane to be installed must be specified, and include, but not be limited to: material, geometry, thickness, nominal pore size, molecular weight cut-off, maximum transmembrane pressure and compatibility to any chemicals that may be used in pretreatment. The expected useful life and removal efficiencies of targeted contaminants of the membranes should also be evaluated.

2. Flux Rate – The approved membrane flux (flow per unit of membrane area) will be determined by the data obtained during the pilot or by other information provided by the manufacturer. In general, a conservative flux rate will be used and the rate must be approved by the Water Bureau.

3. Capacity – In most cases, at least two skids must be provided. The capacity of the plant must be designed to produce finished water at a rate greater than or equal to the projected maximum day demands with one skid out of service at the approved flux rate.

4. Pretreatment – Any chemical conditioning, prefiltration or other types of treatment utilized before the membranes must be described in detail, including the purpose and any chemicals to be used.

5. Backwashing and Chemical Cleaning – Each of these processes must be described in detail including the criteria to be used to initiate a backwash or chemical cleaning, proposed frequencies, amount of air and/or water to be used for each process plus any chemicals to be used and methods of disposal for backwash water and spent cleaning solutions. All chemical to be used in these processes must be ANSI/NSF Standard 60 approved.

6. Integrity Testing – Direct and indirect methods to determine the overall condition of the membranes must be specified. This will include a description of the method, equipment used and testing frequencies of each method. Direct methods (pressure decay, vacuum decay, bubble point, etc.) should be done for each unit at least daily. The Water Bureau may require periodic testing with more sensitive tests, like sonic testing, every 90 days. Indirect methods (particle counters, turbidimeters) should be done continuously.

7. Control Limits – Integrity test results must be compared to an upper control limit, that if exceeded, indicates a potential problem with the membranes and requires corrective action. If the control limit is exceeded, the membrane unit is required to be taken out of service and repaired. During the design phase, the manufacturer must provide calculations that show a relationship between log removal and the number of broken fibers which requires demonstration of the sensitivity of the integrity test on the full scale units. If membranes are installed as a bin requirement for LT2ESWTR compliance, the upper control limits must be set to indicate that Cryptosporidium removal credits are met as established by the Water Bureau. The upper control limits can be established by following the protocols in Chapter 4 of the *Membrane Filtration Guidance Manual.*

8. Redundant Controls – All critical controls, including computers, PLC or other software, air compressors, valves and any other components critical for plant operation must be provided with functioning backup units.

9. Cross Connections – The plant must be designed to eliminate or prevent cross connections. Special attention must be given to all chemical feed systems and both cleaning system and waste piping since those are common areas where cross connections are found in membrane plants.

10. Laboratory – Sufficient on-line analytical equipment and corresponding bench units (for confirmation and calibration) must be provided. Required equipment is based on the type of source water being treated, types of contaminants being removed through the treatment plant, and the degree of automation intended. For example, surface water sources must monitor for turbidity and disinfectant residual, while groundwater sources may be required to monitor for specific contaminants such as iron, radium, or arsenic.

5. Disinfection – General

Continuous disinfection is recommended for all water systems as an additional public health safeguard, and is required for all Subpart H systems and certain other types of treatment systems (phosphate addition, aeration, etc.). The Ground Water Rule includes possible additional disinfection requirements for systems with unresolved sanitary defects.

Disinfectant residual requirements for Subpart H systems are specified in R325.10611a (required minimum residual) and R325.10610a (maximum allowed residual) of the Michigan Safe Drinking Water Act. Disinfectant residual recommendations for non-Subpart H systems are specified in Section 4.3.3 of Recommended Standards.

6. Disinfection – Chlorine Gas

In addition to the requirements of Recommended Standards, the following design standards shall apply:

a. Other regulations, such as: EPA – Risk Management and Clean Air Act; OSHA – Process Safety Management; Homeland Security;and applicable Fire Codes, should be reviewed for possible additional requirements.

b. All chlorine cylinders shall be contained in the chlorine storage room. Vacuum regulators should be located on individual chlorine cylinders in service. The use of pressurized chlorine gas lines and manifolds is strongly discouraged and, if utilized, must be contained in the chlorine storage room.

c. Chlorinators should be housed in a room separate from but adjacent to the chlorine storage room. This requirement is to minimize the need to enter the storage room to adjust feed rates and to minimize the potential for equipment damage caused by chlorine leaks. A gas-tight, shatter resistant window shall be present for viewing the storage and chlorinator rooms from an interior wall of the plant.

d. The chlorine storage room shall only be accessible from the outside and contain no floor drains. The exterior access door for the chlorine storage area must open outward, being equipped with panic bar hardware on the interior. A small viewing window should be present in the door or adjacent to the door in the exterior wall to allow operator examination of the room before entry. A window on an exterior well house door may be eliminated for security issues. Loading dock doors shall also open outward and be equipped with the appropriate moldings, gaskets, and weather stripping to minimize gas leakage to the exterior. Inside access to the chlorinator room shall be acceptable only if chlorine gas is supplied under vacuum.

e. All access doors should be properly labeled with appropriate warning signs.

f. Chlorinator room temperature should be maintained at 60 degrees Fahrenheit and protected from excessive heat. The chlorine storage room shall be maintained at a temperature 5 to 10 degrees Fahrenheit cooler than the chlorinator room to minimize the potential for re-liquification of the gas.

g. A pressure relief valve shall be located on the chlorine vacuum line within the vacuum regulator to prevent gas pressurization of the chlorinator. This valve should be vented to the outside to an area where people are not usually located.

h. There shall be no exterior windows to chlorine storage rooms other than the small viewing window at the entrance. (In order to minimize the potential for heat build-up from the sun and to minimize vandalism.)

i. Scales shall be constructed of durable material to withstand the aggressive environment and situated such that they can be easily and accurately read through a viewing window or use of a remote readout. This type of design will minimize the need to enter the chlorine storage area to take readings. Scales selected when the expected chlorine use is less than 2 pounds per day should have gradations to allow for precise daily readings (i.e. ounces vs. 0.5 pound increments).

j. Lighting fixtures within the chlorine storage area shall be suitable for use in an aggressive environment and, if possible, designed to operate during a chlorine gas release.

k. Electrical components within the chlorine storage area should be minimized. Motors for louvers, cylinder cranes, and ventilation equipment shall be suitable for use in an aggressive environment. Convenience electrical components, such as outlets, should be avoided. All electrical systems for the chlorine storage area shall be on dedicated circuits.

l. Chemical scrubbing systems should be considered for treating the exhaust from a chlorine release where such exhaust may otherwise represent a health or environmental hazard to the surrounding area.

m. All ventilation and duct work within a chlorine storage room shall be separated from domestic building ventilation systems. All chlorine room duct work should be gas tight and not pass through other rooms or areas of the building. Chlorine room exhaust duct work should not be placed near building entrances or air intakes.

n. Leak detectors shall be located 1 foot above the floor of the chlorine storage room and shall activate an alarm when a chlorine leak occurs. It is preferable that the detector be capable of differentiating between two or more chlorine concentrations to alert personnel of the severity of the release. This would help determine the appropriate procedure for entrance to the room, ventilation, or other solutions.

o. Service water to injectors/eductors shall be of adequate supply and pressure to operate feed equipment within the needed chlorine dosage range for the proposed system. All service water shall be properly protected by the appropriate cross connection control device.

p. Placement of injectors/eductors should be carefully evaluated. Current system operation and chlorination practices should also be reviewed before design. In some cases, it may be appropriate to locate the injector/eductor in the chlorinator room with distribution of highly chlorinated water to the point of application. In other situations, it may be best to locate the eductor/injector can at the point of application with distribution of chlorine gas through plastic tubing under vacuum to the point of application.

q. Combustible materials should not be stored in chlorine rooms.

r. Fire sprinkling systems should not be installed in chlorine rooms.

7. Treatment – Arsenic Removal

There are several approved types of arsenic removal treatment technologies, including conventional iron removal, modified iron removal, adsorptive media, reverse osmosis and ion exchange. In addition to the requirements of Recommended Standards For Water Works, design of arsenic removal systems should conform to the *Design and Operational Requirements For Arsenic Removal Treatment Systems For Compliance With The Arsenic MCL* and *Disposal of Backwash Water From Arsenic Removal Units* policies which are located in Appendix A.

Arsenic can be naturally present in two forms: As(III) (arsenite) and As(V) (arsenate). Nearly all commonly available arsenic removal technologies are much more effective at removing As(V). Therefore, As(III) needs to be converted to As(V) in almost all cases. Pre-oxidation by chlorine, permanganate, ozone or solid phase oxidants is critical for achieving optimal performance. Aeration alone usually is not able to convert As(III) to As(V). Unless speciation is done in the field, it should be assumed that all arsenic is in the As(III) state, and therefore pre-oxidation is required for Community Water Systems (CWS) installing arsenic treatment. Many of the available arsenic removal technologies rely in part on the oxidation and removal of iron. Phosphate inhibits the oxidation of iron; therefore, if phosphate is added for corrosion control or other reasons, it should be added downstream of the treatment units.

a. Treatment Techniques

1. Conventional iron removal systems using oxidation and filtration are effective in removing arsenic. When the iron to arsenic ratio in the raw water is 20:1 (or greater) respectively, these types of systems work well. In some cases, adding a ferric coagulant may be beneficial to optimize arsenic removal. By oxidizing both the iron and arsenic in the raw water, the As(V) is adsorbed onto the iron hydroxide precipitates that are removed by the filtration process. Filtration rates are usually in the 2 - 4 gpm/ft^2 range.

2. Modified iron removal can be used when the iron to arsenic ratio is less than 20:1. These systems work similar to conventional iron removal systems, but either use a proprietary media or add ferric to maximize arsenic removal efficiencies. These types of systems include manganese greensand systems and other manganese-dioxide (MnO_2) based medias. Filtration rates can vary greatly from 2 - 10 gpm/ft^2 and are determined on a case by case basis.

3. Adsorption medias remove arsenic from water by attachment of As onto the surface of a porous solid. Available medias are currently iron, alumina, or titanium based. Care must be taken when comparing these medias since they all act a little different from each other. As an example, some adsorptive medias can be

regenerated on-site while most others cannot. Also, some require pretreatment (iron removal) if iron concentrations are above certain levels.

4. Anion Exchange is the physical process where ions on the solid phase (resin) are exchanged for an ion in the feed water. This process only works if the arsenic is in the arsenate (V) form and the pH is in the 6.5 - 9.0 range. In general, ion exchange for arsenic removal is only applicable for low TDS, low sulfate waters. Chloride is also a competing ion during this process and chloride-form resins are often used in arsenic removal. Regeneration of the resin must be done well before breakthrough to prevent chromatographic peaking (the release of arsenic or nitrate that can be 10 – 100 times higher than levels in the raw water). Typical loading rates are 8 -12 gpm/ft^2 with empty bed contact times (EBCT) anywhere from 2 – 5 minutes.

b. Arsenic Backwash Water Disposal Options

The disposal of backwash water from arsenic removal treatment units can be complicated. Options include: connection to an existing sanitary sewer that flows to a wastewater treatment facility, discharge to a surface water or discharge to the groundwater. In most cases, a discharge permit or separate authorization is required. Please refer to the *Disposal of Backwash Water From Arsenic Removal Units* policy in Appendix A for further information.

8. Sanitary/Discharge Piping Design

a. All backwash discharge lines shall be adequately designed to handle the designed backwash flow rate.

b. Backwash basins or holding tanks shall be adequately sized to accommodate the volume of at least one (preferably two) filter backwash while assuming the water is being drained from the basin via gravity flow.

c. An air gap between the filter and backwash basin or holding tanks must be provided to avoid a cross connection

d. If the backwash line is connecting to a sewer or manhole, the backwash discharge line shall be installed with a trap to prevent sewer gases from entering the treatment plant.

e. The plumbing code requires that the backwash drain line be vented. This assures gravity flow and prevents a siphon from emptying the trap.

9. Fluoridation

In addition to the requirements of Recommended Standards, design of fluoride feed systems should conform to the following guidelines:

a. Fluoride feed equipment shall include a feed tank (day tank) capable of holding no more than enough fluoride solution to meet maximum daily demands.

b. For fluorosilicic acid feed systems, a scale shall be provided for measuring the amount (weight) of fluoride fed and the scale should be sized and graduated to allow for proper daily readings. Scales shall be periodically calibrated.
c. Feed pumps should be sized to feed fluoride near the midpoint of their range (between 30-70% of capacity). Oversized feed pumps shall not be used because serious overfeeds can occur if they are accidentally set too high.

d. A graduated cylinder should be installed at the lowest point possible between the day tank and feed pump for purposes of calibrating the feed pump.

e. Whenever possible, the fluoride injection point should be upstream of plant storage so that in the event of an overfeed, the concentration peak will be dampened, and the system will have more time to detect and eliminate public exposure. In a treatment plant, an ideal location may be the filter effluent line prior to the clear well.

f. The point of application of fluoride, if into a horizontal pipe, should be in the lower one third of the pipe, ideally 45 degrees from the bottom of the pipe. The end of the injection line should extend into the pipe approximately one third of the pipe's diameter to obtain uniform disbursement in the flow of water..

g. For well supplies, the point of fluoride injection shall be on the discharge side of the check valve so the injection point is always under positive pressure. Attempts should be made to locate the injection point in treatment plants at a place continuously under positive pressure. However, this may prove difficult in treatment plants that do not operate 24 hours per day. Redundant anti-siphon devices and an isolation valve as described in the following item will be considered acceptable anti-siphon protection for shift operations. Where open channels or open basins are utilized for fluoride application, a suitable air gap must be provided.

h. Redundant diaphragm type anti-siphon devices must be installed in the fluoride feed line. The anti-siphon device should have a diaphragm that is spring-loaded in the closed position. These devices should be located at the fluoride injection point and at the metering pump head on the discharge side. The anti-siphon device on the head of the metering pump should be selected so that it will provide the necessary back pressure required by the manufacturer of the metering pump. Often these devices are integral to the pump and are part of a multi-purpose valve package which contains a back pressure valve, pressure relief valve, anti-siphon valve and feed valve. Further, an isolation valve must be provided on the fluoride feed line near the fluoride feed equipment, and shift operations must routinely close this isolation valve whenever the plant is shut down.

i. Vacuum testing for all anti-siphon devices and multi-purpose valves should be performed twice per year, or more frequently if based on the manufacturer's recommendations. All anti-siphon devices and multi-purpose valves must be dismantled and visually inspected at least once per year, or more frequently if based on the manufacturer's recommendations.

j. The fluoride solution feed pump should be located on a shelf not more than 4 feet higher than the lowest normal level of liquid in the carboy or day tank. A flooded suction line is not recommended in water fluoridation. The suction line should be as short and as straight as possible. There should be a foot-valve and strainer at the bottom of the suction line and, if necessary, a weight to hold it down.

k. The priming switch on the feed pump should be spring loaded to prevent the pump from being started erroneously with the switch in the priming position.

l. An in-line mixer or a small mixing tank should be installed in the finished water line from the water plant if the first customer is <100 feet from the fluoride injection point. This minimum distance of 100 feet assumes there are typical valves and bends in the water line that allow for adequate mixing.

m. A corporation stop valve must be provided on the line at the fluoride injection point when injecting fluoride under pressure.

n. A safety chain must always be installed in the assembly at the fluoride injection point to protect the water plant operator if a corporation stop valve assembly is used.

o. The electrical outlet for the fluoride feed equipment shall be wired such that it is only energized when a well or raw water pump/motor is energized. The outlet must also have a secondary control (flow switch, pressure switch, or other appropriate signal) to prevent accidental overfeed. Typically, this redundancy is accomplished by wiring the two control signals in series with the outlet. In situations where raw water pumping and/or metering facilities are remote, other means of providing redundant controls are required. The use of PLC's or SCADA systems as the only means to provide fluoride feed control is generally not allowed.

10. Pumping Facilities

a. Drainage

Pumping facilities, motors, controls, and other electrical equipment shall be located above grade, or have adequately-sized, positive drainage to grade. For example, a partially-buried station constructed on a hillside with gravity drainage to grade may be acceptable.

b. Capacity

For all pumping installations, the combination of available pumping and storage must be capable of meeting peak demands with the largest pumping unit removed from service. Pumping stations that serve an area having adequate elevated storage must be capable of meeting maximum daily demand. Stations that serve an area having an inadequate volume of elevated storage may be required to meet the maximum hourly (or greater) demand. Stations serving an area having only hydropneumatic storage must meet the peak instantaneous demand. Stations using variable speed pumps in lieu of storage must meet the peak instantaneous demand, and may be required to have emergency power. An adequate amount of hydropneumatic storage should be provided to maintain system pressure from the time power is lost until the time standby power facilities are engaged. Additional information regarding the determination of peak demands can be found in Part 12, Reliabilty, of this document.

c. Station Bypass and Backup Power

Booster pumping stations whose failure would result in unacceptably low (< 35 psi under normal operating conditions and <20 psi under all conditions) pressures in the station's service area must be equipped with emergency power capability. Automatic switchover to backup power may also be required.

Booster pumping stations that serve an area where the pressure will be greater than 20 psi when a failure occurs, must be installed with a bypass line with an automatic opening valve.

11. Wells and Booster Pumping Controls

All wells and booster pumps controls should be provided with motor run timers and Hand-Off-Automatic (H-O-A) switches.

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PART 11 Distribution Systems and Storage Tanks

Applicable references

- Michigan Safe Drinking Water Act, Parts 10, 11 and 16
- Recommended Standards For Water Works, Parts 2, 7 and 8
- DEQ-Water Bureau Policy, DWRP-03-002, *Permit Requirements For Water Main Construction*

1. Capacity; Fire Flow Demand

Required peak demand, including fire flow must be identified in the basis of design. ISO (Guide for Determination of Needed Fire Flow) and AWWA (Distribution System Requirements for Fire Protection AWWA Manual M31) offer guidance in determining appropriate fire flows. The design engineer may be required to demonstrate that the proposed water main has sufficient hydraulic capacity to meet the required demands by flow testing, modeling, or other methods.

2. Pressure

Water supply master planning should identify locations in the service area where high and low static pressures are anticipated. If these areas are to be served, the design should conform to the pressure recommendations provided in Recommended Standards For Water Works

3. Fire Hydrants

In areas where water mains are proposed without providing fire protection but fire protection may be provided in the future, provisions should be made for future hydrant installation. If hydrants are to be installed prior to the availability of fire protection capacity, the design must ensure that they can not be operated until fire protection capacity is available and should be identified as such on the water system general plan. Water system owners should be aware that the appearance of hydrants in areas where fire flows are not available could be considered a liability.

Project plans or specifications should indicate the conditions under which hydrant weep holes shall be plugged such as high ground water table, poor draining soils, contaminated soils, etc.

4. Water Main Replacement

Water system hydraulic modeling and master planning should identify water mains within the distribution system that are inadequately sized. The deficient areas should be indicated on the water system general plan. This determination can be made through flow testing and/or modeling.

5. Water Main Sizing

Unless it results in improved capacity, connecting new water main to an existing water main with insufficient capacity is prohibited.

6. Dead-Ends

Since there is a desire to provide reliable water service of high quality to all customers on a continuous basis, dead-end water mains will generally not be approved. Factors the Water Bureau will consider while reviewing dead-end water main extensions include:

- Is there a current water system master plan in place?
- Does the proposed water main extension conform to the master plan?
- Does the proposed water main extension provide adequate flows and pressures?
- Is there a readily available means to loop the water main?
- Are provisions included to facilitate looping in the future? (easement or stub)
- Does the proposed dead-end create an unreliable situation in terms of water main length and customers?
- Is the proposed water main extension design going to adversely impact water quality?
- What is the status of the utilities flushing and valve turning programs?

If the Water Bureau deems that a water system or portion of the water system is not adequate to provide a continuous and adequate supply of water, approval of future water main extensions may be denied in accordance with Act 399.

7. Water Main Ownership

There are a number of reasons why a water utility should own all portions of the distribution system it serves, regardless of whether or not the mains are located on private property. The reasons fall into four main categories: liability, public relations, future service, and cost.

a. Liability

In today's legal climate, there is no guarantee the utility would be protected from claims by individual water customers against both the private water main owner and the public utility for problems with the water system. Improper repair or untimely response to a loss of pressure may lead to contamination of the private system and threaten public health. Unauthorized or improper use of a private hydrant could result in a cross connection incident contaminating the private system and possibly the public system. Also, water system pressures may be seriously reduced through improper hydrant use. Finally, poorly maintained hydrants, valves, and water mains could prevent or delay fire fighting response. If the utility owns the water mains located in private property, the mains, hydrants, and valves will likely be regularly maintained and the chance for interruptions in service will be minimized. Consequently, the likelihood of receiving claims that the utility is legally at fault for problems with the water system will be reduced.

b. Public Relations

Properly run water utilities understand the importance and benefits of maintaining high consumer confidence and therefore, make the necessary effort to present a good public image. This effort can pay off in the form of customer acceptance of necessary rate increases, and patience during scheduled flushing, maintenance, repairs, etc. However, lack of control over private water mains may counteract these efforts.

For example, an ordinary citizen observing a rusting, privately owned hydrant may assume it is public property and wonder why "their" investment is not being maintained. Also, unsupervised repair by private contractors may be done in an unprofessional manor which again may be assumed by a citizen to be city crews. Similarly, other utilities which have obtained easements on private property may become irritated with the water utility because of damage to their lines during poor repair by inept private contractors. The public utility's reply, "That's not our main" may then further damage the utility's public image. Control over water mains on private property can minimize many of these headaches.

c. Future Service

One consideration that a utility might overlook when it neglects to take over a newly constructed main in private property is the potential for future service. The utility may find it necessary to extend water main from the private system to provide a loop or to serve additional customers. Without control of the private main a construction permit for the public extension could not be issued. Obtaining easements after the fact often prove more difficult than if they were obtained initially. Even if the owner is agreeable to turning over ownership of a private water main needed by the public utility to service new areas, the utility may not be willing to accept the materials, size, or quality of construction of the private mains. Had the private main been public initially, that problem could have been avoided by making sure the mains conformed to the utility's water system master plan and standard construction specifications. Similarly, the public utility may not have control over the addition of new customers either within the current or adjacent property.

d. Cost

A final area of concern is unanticipated costs both in the short and long term to the utility as a result of lack of control of private mains. For example, in an instance where a private system has individual metering, there is little incentive for the owner to repair leaks or control hydrant use. The wasted or un-metered water translates to a direct loss to the utility. Therefore, master meters should be provided at the connection point to privately owned water mains. Meters should be sized to be able to accurately measure both high and low flows. Also, should the utility find itself in a position where it needs to assume ownership of some private water main to create a necessary loop or serve additional customers, it may take on additional costs. The utility may find itself maintaining a poorly designed and constructed system with inferior and/or incompatible materials. Furthermore, depending on how severely the utility needs the private water main and how cooperative the owner is, the utility may not be in a good position to negotiate a fair price for obtaining a necessary easement. The owner of the private system may view the position the utility is in as an opportunity to profit. All of these scenarios provide examples of how a utility could save money by requiring ownership of the water main in private property from the start.

For these reasons, water utilities should strive to obtain ownership of all new distribution system piping regardless if it's located in public right of way or private property. One less desirable, but acceptable alternative to owning water mains in private property is establishing a formal maintenance agreement where the public utility will operate and maintain the privately owned water mains. This practice should be combined with requiring the private mains to conform to the standard water system construction specifications of the local utility.

See the *Permit Requirements For Water Main Construction* policy located in Appendix A for definitions and requirements for water main, customer site piping, and service connections.

8. Approved Water Mains

The below table lists water mains approved for use in public water systems. It includes the pipe material, appropriate class or rating plus material and installation standards.

Pipe Material	Class/Rating	Material Standard(s)	Installation Standard(s)
Ductile Iron	Thickness Class ≥ 50 Pressure Class ≥ 150	AWWA C150 AWWA C151	AWWA C600
Poly Vinyl Chloride (PVC) 4" thru 12"	DR ≤ 18 or SDR ≤ 21	AWWA C900	AWWA C605
Poly Vinyl Chloride (PVC) 14" thru 48"	DR ≤ 18 or SDR ≤ 21	AWWA C905	AWWA C605
Poly Vinyl Chloride (PVC) Schedule Pipe ≤ 8"	Schedule 80 (≤ DR18)	ASTM D1785	AWWA C605
Molecularly Oriented PVC Pipe (PVCO) 4" thru 24"	Pressure Class ≥ 150	AWWA C909	AWWA C605
High Density Polyethylene (HDPE) 4" thru 63"	DR ≤11	AWWA C906	AWWA C605*
Reinforced Concrete, Steel Cylinder Type 30" thru 144"	Must Specify >150 psi	AWWA C300	
Prestressed Concrete, Steel Cylinder Type 16" thru 144"	400 psi	AWWA C301 AWWA C304	
Concrete, Bar Wrapped, Steel Cylinder Type 10" thru 72"	Must Specify >150 psi	AWWA C303	
Steel 6" and larger	Must Specify >150 psi	AWWA C200	
Stainless Steel 4" and larger	Must Specify >150 psi	AWWA C220	
Asbestos Cement 4" thru 16"	Pressure Class ≥ 150	AWWA C400 See also AWWA C401	AWWA C603
Asbestos Cement 18" thru 42"	Pipe Class ≥ 30	AWWA C402 See also AWWA C403	AWWA C603

*See #17 in this part for special pressure testing considerations for HDPE water mains

Each pipe material must meet ANSI/NSF Standard 61 and the certification should be stamped on the exterior wall of the pipe. In addition, **all** plastic pipe must meet NSF Standard 14 and be stamped "NSF-pw" on the exterior pipe wall.

The appropriate selection of any of these kinds and classes of pipe, for each installation, must consider the following factors:

- Depth of bury
- Temperature
- Freezing and the ability to thaw
- Electrical continuity
- Internal and external corrosion
- Excessive normal working pressure
- Excessive pressure increases (water hammer)
- Suitability to tapping
- Adaptability to repair
- Frictional losses (C-factor)
- Installation methods
- Restraint methods
- Backfill material
- Vibration due to railroads, truck traffic, etc.
- Pipe storage and handling
- Pipe locating (Tracer wire for non-metallic pipe)
- Joint deflection
- Permeation of contaminants
- Expansion/Contraction of pipe
- Compatibility with existing materials and sizes

Certain small Type I public water supplies, not likely to be connected to a municipal water system, may be permitted by the Water Bureau to use the same pipe materials approved for use on Type II and Type III water supplies.

9. Fusible Thermoplastic Pipe Requirements

The design, installation, and use of fusible thermoplastic pipe in Type I water systems must comply with following items.

a. For HDPE pipe, appurtenances, and installation:

   The pipe must meet American Water Works Association (AWWA Standard C901 or C906 and the C901 or C906 identification must appear on the exterior wall print line.

   All HDPE materials must be listed and approved for use with potable water under ANSI/NSF standard 14. ANSI/NSF standard 14 meets the requirements of ANSI/NSF standard 61. The exterior wall print line of all HDPE pipe proposed must bear the NSF-pw identification.

   In addition to AWWA C901 or C906 and ANSI/NSF standard requirements, HDPE pipe shall be manufactured from high density PE 3408 polyethylene resin, having a dimension ratio (DR) of 11 or less and a minimum working pressure rating of 160 psi. The DR is calculated as the outside diameter of the pipe divided by the minimum wall thickness.

b. Fusible PVC pipe, appurtenances, and installation:

The pipe must meet American Water Works Association (AWWA) standard C900 or C905 and the C900 or C905 identification must appear on the exterior wall print line.

All fusible PVC materials must be listed and approved for use with potable water under ANSI/NSF standard 14. ANSI/NSF standard 14 meets the requirements of ANSI/NSF standard 61. The exterior wall print line of all fusible PVC pipe must bear the NSF-PW identification.

In addition to AWWA C900 or C906 and ANSI/NSF standard requirements, PVC pipe shall have a dimension ratio (DR) of 21 or less and a minimum working pressure rating of 150 psi. The DR is calculated as the outside diameter of the pipe divided by the minimum wall thickness.

c. Requirements for both HDPE and fusible PVC pipe

Critical crossings, such as surface water crossings, require valving on each side of the crossing so that the section of piping may be isolated. In addition, a valve manhole with corporation stops on each side of the valve shall be installed for purposes of future chlorination, sampling, and leak testing.

Due to the high expansion and contraction rates compared to metal pipe materials, adequate restraint must be provided at connections to appurtenances or transitions to different pipe materials. Additional restraint is necessary on each side of the connection point. This restraint may be provided in the form of an anchor ring encased in concrete or other methods as approved by the DEQ. All proposed connection and restraint details shall be included with plans and specifications. The design engineer should refer to manufacturer's recommendations and/or the Plastic Pipe Institute for guidance on the best method and required degree of restraint.

Connections to fusible pipe shall not be made immediately after the pipe has been installed. It is recommended to wait overnight so that the pipe can approach an equilibrium temperature with its surrounding environment. Linear dimensions will vary with temperature change.

In addition, fusible pipe must be properly aligned at all transitions to other water mains and appurtenances and a tracer wire adequate for future location of the pipe shall be installed with all HDPE piping projects.

10. Water Main Reuse

Generally, used water main materials are not recommended for reuse. Documentation of previous use, current condition, and restoration methods must be provided to the Water Bureau.

11. Dry Water Mains

Water systems from time to time want to install water mains that will not be placed into immediate service. These mains can remain “dry” for several years until public water service becomes available in that area. In these circumstances, the following conditions should be followed.

a. Fire hydrant bonnets shall not be installed until a community water supply is available to avoid confusion regarding fire protection capabilities.
b. Immediately after installation, the main shall be pressure tested and a leakage calculation conducted to determine if the amount of leakage is acceptable in accordance with industry standards.
c. Prior to connection to a community water system, the water main shall be disinfected, flushed and sampled in accordance with AWWA and Water Bureau requirements.

12. Packing and Joining Materials

These materials should not promote the growth of bacteria and should allow disinfection to be effective using the AWWA disinfection method for piping systems.

According to American Ductile Iron Pipe Company, Fluoroelastomer (Fluorel, Viton®, FKM) gaskets are commonly used for protecting against aromatic hydrocarbon contamination, while nitrile (Buna-N Nitrile, Acrylonitrile Butadiene Rubber, NBR) gaskets are commonly used to protect against non-aromatic hydrocarbons. Nitrile gasket rubber is chemically resistant, but is not as resistant to permeation as Fluoroelastomer. Both of these gaskets are acceptable to use in areas of volatile organic contamination.

13. Surface Water Crossings

The required Isolation valves and corporation taps shall be easily accessible, and not subject to flooding. In addition, the valve closest to the supply source shall be in a manhole or valve chamber large enough for human access.

Prior to construction, a Stream Crossing permit from the DEQ Land and Water Management Division may be required in accordance with Part 301 *Inland Lakes and Streams Rules* of Act 451. Land and Water Management Division district staff should be contacted to determine whether a permit is required.

As, stated in Part 301 Rule 22 (2), where directional drilling is used to conduct stream crossings, it will not be regulated by Part 301 if all of the following provisions are satisfied.

a. A minimum of 10 feet is maintained between the top of the conduit and the bottom of the lake or stream
b. The entry and exit points are located far enough away from the lake or stream banks to assure that bank disturbance does not occur
c. The drilling or boring sites (pits) are located outside applicable natural river designation setback requirements
d. The drilling or boring operations will not result in eruption/release of any drilling fluids up through the ground and into the lake or stream

It should also be noted that Rule 26 of Part 301 requires “all pipe trenches shall be excavated to a depth which will provide a minimum cover of 30 inches from the bed of the stream to the top of the pipe”. This requirement of 30 inches of separation supercedes Recommended Standards recommendation of 24 inches. In addition to open channels, this separation must also be provided at stream culverts.

14. Isolation of Water Mains from Sources of Contamination

The term “sewers” includes, but is not limited to, sanitary sewers, storm sewers, and catch basin leads.

If separation less than the standard distances is proposed, a variance must be specifically requested and justification must be provided in the permit application submittal. When standard separation distances can not be maintained, and the provisions in Recommended Standards For Water Works, Part 8.8.4 are exercised instead, the separation distances between utilities should be maximized. Any deviations from the required separation distances must be approved by the Water Bureau. See Part 13, No. 15 for information pertaining to requesting variances.

Water mains shall not pass under or through any sanitary or storm manhole.

15. Distribution System Valves

In general, valves should be provided at all water main intersections (tees, crosses, wyes, etc), on all but one branch of the fitting and at certain distances as specified in Recommended Standards along straight stretches of main.

16. Air Relief Valves

The air relief valve discharge piping may be susceptible to freezing if water accumulates within the pipe. A means to manually drain the discharge pipe should be provided in a manner that does not create a cross connection.

In certain circumstances, locating a fire hydrant at high points along a water main is an acceptable “provision” for the release of air from the system.

17. Pressure Testing

Pressure testing is required for newly installed or rehabilitated water mains, and all testing requirements must be met before placing it into service. The testing requirements shall be equal to or exceed the applicable AWWA standards as outlined in Act 399.

Special consideration must be given to HDPE water main while pressure testing to account for the expansion of the material. Currently, there is no applicable AWWA standard for pressure testing of HDPE water main. Lacking an applicable standard, specific test procedures must be included in the project specifications. The pressure test procedure for HDPE water main must include an initial expansion phase before conducting the actual pressure test. The pressure test should be conducted at 150 psi for at least 2 hours, to match the requirements for testing of other water main materials. The Plastic Pipe Institute’s Handbook of Polyethylene Pipe is a good resource for determining the appropriate specifications for such a pressure test. AWWA Manual M55 also has valuable information on pressure testing of HDPE pipe.

18. Disinfection

High strength chlorine solution should not be used to disinfect polyethylene pipe. Disinfecting solutions should not exceed 12.5% active chlorine, otherwise, degradation of the pipe may occur. When ends of pipe or fittings are swabbed on polyethylene pipe, the solution should contain 12.5% or less of active chlorine to eliminate the possibility of degradation.

All disinfection procedures should be witnessed by the designated engineering inspector and a representative of the water utility.

19. Disinfection – Seasonal Distribution Systems

All water system components within a seasonal water system should be disinfected and tested for bacteriological contamination as if newly installed prior to being placed back into service.

20. Distribution System Records

The supplier of water shall maintain adequate records on the operation of the water distribution system, on the location and type of maintenance performed, and on the type of material and appurtenances used. Specific items such as valves, fire hydrants, flushing hydrants, blow-offs, air relief valves, pressure reducing valves, pressure indicating and recording gauges, chlorine residual recorders, service connections and etc. shall have separate individual records kept and shall show or describe their exact location and measured distances to reference points. These records must be updated as changes to the system are made.

For the purposes of simplifying and enhancing operation of the distribution system, water utilities are strongly encouraged to develop and periodically update standard specifications for distribution system components. Requiring all new distribution system construction to conform to standard specifications promotes uniformity, ensures only approved materials and appurtenances are installed, minimizes disputes over what size, material, or brand of distribution system components to install, and simplifies distribution system record keeping and repair/replacement parts inventory. Unless a formal request from the water utility is made to the Water Bureau to use substitute specifications (i.e. specialized construction), new construction should conform to the standard specifications if they exist. A representative of the water utility should be reviewing each proposed distribution system project to ensure that it conforms to the standard specifications. Furthermore, the water utility should routinely request as built prints of all newly constructed portions of the distribution systems in which to update their distribution system records.

Databases created by Water Bureau staff specifically for hydrant and valve records are available upon request.

21. Water Storage Tanks – General; Communication Antennas

Due to the popularity of communication antennas mounted to elevated water tanks, the design of newly constructed tanks should include provisions to facilitate the installation of such devices. As existing tanks are retrofitted to accommodate the installation of communication antennas, the associated work should be performed under the supervision of a qualified engineer to ensure that the water quality, ease of operation and maintenance, cost of future maintenance, safety, security and structural integrity are not adversely affected.

22. Storage Tank Sizing

Many factors need to be considered in the design phase when determining the appropriate size of a water storage tank. Items such as current and projected water demands, source capacity, fire fighting demands, system hydraulics, water operating level, the location of the storage tank, and the necessity of an altitude valve should be considered.

Water stagnation in the tank should be minimized to control the formation of ice, the formation of disinfection byproducts, loss of disinfectant residual, and the deterioration of water quality. An analysis of the tank's susceptibility to stagnation should be performed in the design phase.

23. Storage Tank Access

It is recommended that a manway or access hatch be provided at grade for ground level storage tanks.

At least one access hatch should have a minimum opening size of 24-inches by 30-inches to facilitate the entry of a rescue basket in an injury or emergency.

If properly designed, the tank vent can be utilized as a secondary access point for the tank.

24. Overflow Detail

Recommended Standards requires an internal overflow pipe to be placed in the access tube. This design is necessary to prevent the tank from draining should the overflow pipe begin to leak. This arrangement also allows a repair to be completed in the access tube without having to drain the tank.

A basis of design for the overflow pipe size and capacity shall be provided for a proposed storage tank. The overflow capacity should exceed current and future maximum filling rates.

25. Venting

A basis of design for the vent size and capacity shall be provided to the Water Bureau for a proposed storage tank. The vent capacity should exceed current and future maximum air exchange rates.

If properly designed, the tank vent can be utilized as a secondary access point for the tank. If the tank has compartments, each compartment shall be properly vented.

The tank vent should be located at a point easily accessible for inspection.

26. Water Level Warning Devices

It is recommended that high and low level alarms be equipped with a remote alerting system capable of alerting multiple parties.

27. Freezing

In colder climates, additional tank features may need to be considered, including insulated coatings, water circulation systems, and overflow flap gates.

28. Ground Level Storage – Bottom Elevation

To assist in ease of maintenance, the tank bottom should be located at an elevation sufficient to drain the tank by gravity.

29. Grading

Area grading should allow adequate space for maintenance activities and should consider the potential for unauthorized access to the tank site. The initial design and ongoing maintenance activities should prevent erosion around the tank's perimeter.

30. Direct Pumping Without Storage Tanks

Direct pumping of water without elevated or hydropneumatic storage of water will be considered for approval only in very unusual cases, such as where ample ground level storage and standby power facilities are available for reliable pumping into large distribution systems.

In situations where adjustable speed pumping units are proposed to be controlled by discharge system pressure, an adequate amount of hydropneumatic storage should be provided to maintain system pressure from the time power is lost until the time standby power facilities are engaged.

31. Water System Storage – System Service Limits

Recommended Standards states that hydropneumatic storage should not be used for systems serving more than 150 living units. The limit of 150 living units also applies to individual pressure districts within a large water system that are served by a booster pumping station.

32. Hydropneumatic Storage Tanks – Miscellaneous

a. All connections to the tank shall be welded, threaded or properly restrained by other means.

b. The exterior and interior of tanks may be coated to prolong life and prevent corrosion. If an interior coating is used, it must meet ANSI/NSF Standard 61.

c. Dewatering and special air charging devices are required and should be incorporated in the design for all water supplies.

d. Air compressors intended to recharge hydropneumatic potable water storage tanks shall be oil-less and must be fitted with a replaceable air filter.

e. An automatic pressure relief valve should be provided on all hydropneumatic tanks.

f. Separate inlet and outlet piping should be provided where practical, to promote water circulation.

33. Storage Tank Pressure Tests

a. All storage tanks, including gravity storage tanks for the storage of finished water, shall pass a pressure test before being placed into service. One method used for a gravity tank is to measure the drop in water level in a full tank over a 48 hour period. The loss of water during the period should not be detectable.

b. During the test described in (a), the consulting engineer in charge should examine the outside of the tank for any visible leaks and order corrections. A thorough inspection for leakage is necessary at the outside bottom area where the vertical and horizontal walls join. Should any leakage be detected, appropriate corrections must be undertaken.

c. For storage tanks with bottom elevation located below the groundwater table, such as plant clearwells, the test should include inspection for leakage from infiltration into the basin as well.

34. Storage Tank Disinfection

Before being placed into service after construction, repair or inspection, the storage tank must be disinfected and sampled in accordance with AWWA Standard C652.

The water used for disinfection after the wet interior of a storage tank has been recoated should be wasted, or satisfactory results from a laboratory analysis for volatile organic chemicals should be obtained before the water is allowed to enter the distribution system.

35. Sampling and Threaded Taps

A threaded tap shall be provided for chlorination purposes in the connecting main or riser pipe.

36. Protection and security of Storage Tanks

Suppliers of water shall take precautions to protect storage tanks from trespassers and to prevent introduction of contaminants into the distribution system or storage tanks. The following measures should be considered to prevent trespassing, vandalism, and sabotage:

- Perimeter fencing
- Locked access points
- Barbed wire
- Lighting
- Locked access hatches and manholes
- Intrusion alarms
- Security cameras
- Motion sensors
- Restricted ladder access
- Vehicle barriers
- Reinforced vent screen
- Site location with respect to threats

37. Surveillance and Inspection of Storage Tanks

A program of routine inspection and surveillance of water storage facilities should be executed with competent personnel on an appropriate frequency. Routine inspection should be thorough, including an inspection of the entire site and perimeter for signs of unauthorized entry. In addition to routine site inspections, a more detailed inspection of certain components of the storage facility (i.e. access hatches, vent screens, ladders…) should be performed on a less frequent basis. These inspections can be easily carried out by water utility personnel. The water utility should also educate local law enforcement on the importance of storage tank security and encourage them to assist in surveillance. Any incidents should be reported immediately to the employee in charge, who should implement their local emergency response plan immediately. Finally, water utilities are strongly encouraged to hire a professional tank consultant to perform detailed structural and coating inspections. A quality inspection will cover the entire storage tank interior and exterior, identify areas that need immediate or future maintenance performed, provide cost estimates, and include photo or video documentation with the findings contained in a formal report.

A great deal of interest has occurred regarding underwater inspection of potable water tanks and reservoirs. The advantage of conserving water by eliminating the drainage of the reservoir prior to the inspection is obvious. However, if these inspections are not conducted properly, the safety of the inspection team and the drinking water supply could be in jeopardy. Therefore, the Water Bureau does not recommend on-line reservoir inspections. AWWA Standard C652-02 contains information regarding underwater inspections. As such, the following recommendations, as a minimum, should be followed when conducting an underwater inspection of a potable water tank or reservoir.

a. Underwater inspections should only be conducted on reservoirs where significant repairs or maintenance are not anticipated. Most repairs are best conducted after draining.

b. The reservoir should be isolated from the potable water system during the inspection. Unanticipated demands on the water system during on-line diving inspections could pose serious dangers to the inspection team. Also, contamination to the reservoir by the inspection team could result in and pose serious health problems for the water system users.

c. If a reservoir must be inspected on-line, it should be done during periods when positive flow into the reservoir is maintained or rates into or out of the water storage facility are minimal. For underwater inspection of nonisolated reservoirs with a common inlet/outlet, it is strongly recommended that a positive flow into the storage facility be maintained during the dive.

d. A minimum of 0.5 mg/L of free chlorine or 1.0 mg/L of chloramine should be maintained in the reservoir during the inspection. The chlorine residual should be analyzed and recorded immediately before and after the inspection. If the chlorine residual has dropped from the initial test made prior to entry, sufficient chlorine shall be added to the storage facility to return the chlorine residual to pre-entry levels.

e. Two consecutive safe coliform samples collected 24 hours apart should be obtained from the reservoir (not the sample tap on the riser or inlet/outlet pipe) prior to returning it to service. It is recognized that some situations may warrant deviation from this standard to allow returning the reservoir to service prior to obtaining the coliform results. However, these situations should be discussed with WB staff.

f. All applicable occupational safety and diving regulation requirements must be met.

g. All divers must use totally encapsulated diving dress including dry suit and full face sealed mask with sealed neck dam.

h. All equipment introduced into the water must be dedicated for potable water use and must be disinfected immediately prior to entry into the tank or reservoir. Any equipment making contact with the tank roof must be disinfected again prior to entry into the water. The method of equipment disinfection can be submersion in, spraying with, or sponging with a minimum 200 mg/l free chlorine solution.

i. Construction permits must be issued by the appropriate Water Bureau district office for all interior tank painting and repairs prior to commencing those activities. This includes any proposed underwater repairs. No underwater welding is allowed.

j. There is no requirement to inform the Water Bureau in advance of underwater inspections or cleanings. However, utilities are responsible for water quality in their systems and any liabilities that may result from improper procedures. Any proposed deviations from these recommendations should be discussed with the Water Bureau.

38. Disposal of Spent Chlorine Solutions

See Part 8, No. 32 for additional information pertaining to this subject.

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PART 12 RELIABILITY

Applicable references

- Michigan Safe Drinking Water Act, Parts 8, 10 and 12
- Recommended Standards For Water Works, Part 6
- DEQ-Water Bureau Policy, WB-014, *Guidelines For Issuing Boil Water Advisories To Address Potential Microbial Contamination of Community Water Supplies*

1. Purpose:

To maintain reliability of public water supply systems to assure a continuous supply of water for drinking and household purposes.

2. Hydraulic or Computer Modeling of the Waterworks System

If a public water supply has had or is in need of significant water system improvements, the Water Bureau may require hydraulic or computer modeling of the water distribution system in addition to the required minimum study information. Also, the Water Bureau recommends that all water systems serving greater than 1,000 people conduct hydraulic modeling on a periodic basis. The hydraulic modeling and report should address the following items.

a. Provide a network analysis map showing the pipe number and junction nodes.

b. Have the hydraulic model calibrated by comparing field results to computer simulated results. A table should be included in the study comparing field and computer simulated pressure and fire flow measurements. AWWA guidance suggests that hydraulic models intended to be used for long term planning should be accurate within 5 psi, but more accuracy may be necessary for other modeling applications.

c. Have the hydraulic analysis evaluate the static and residual pressure in the water distribution system for present and future average and maximum day demand conditions.

d. Have the hydraulic analysis evaluate the fire flow capacity of the water distribution system under maximum day demand and with the water distribution system pressure held at 20 psi.

e. Have the hydraulic analysis evaluate pressure and fire flow for the recommended proposed improvements to the water distribution system.

f. Provide pressure and fire flow contour maps with the report. The Water Bureau may request a junction report and pipe report to supplement the pressure and fire flow contour map.

3. Additional Study Considerations

The basis of present demands and projections shall consider, among others, the following factors:

a. The population growth in the total projected area to be served and the population density in unit areas.

b. The extension of the system into new areas.

c. The type of industrial and commercial customers and their patterns of use.

d. The sprinkling and irrigation use, and pattern of use.

e. The fire demand to meet the requirements of the Michigan Insurance Service Office or other recognized fire rating service.

f. Water use for cooling in industrial use and air-conditioning.

g. Unaccounted water use.

h. Recorded distribution system pressure readings.

i. Metering of the water system.

j. Potential for emergency or permanent interconnections with other adjacent systems.

k. Water use agreement between the water system supplier and water system retailer or wholesaler.

l. Water use restriction authorized by ordinances.

m. Demand projections in individual pressure districts.

4. Department Study

If the Water Bureau conducts a study to determine the quantity of water supply needed by a Type I public water supply to satisfy Reliability Study requirements under Part 12 of Act 399, it shall use the factors listed under Part 12 and any others pertinent to the water supply. Determination by the Water Bureau of the quantity of water supply needed will only be made in a limited number of cases where demand is predictable, such as a water system serving an apartment complex or condominiums; or where other rules or guidelines are in effect, such as manufactured housing communities.

5. Complete Treatment Plants - Rated Capacity

Refer to Part 10 of Act 399 for the criteria to establish a capacity rating for an approved surface water supply or complete treatment system.

6. Firm Capacity

(a) It is recommended that systems have the actual capacity for existing wells determined by periodic pump testing.

(b) The firm capacity must be adequate to meet peak instantaneous demands for those systems with hydropneumatic storage. See No.10 of this section for additional information regarding peak instantaneous pumping capacities.

7. Available Capacity Under Contract

The available capacity which can be obtained under contract from another approved public water supply depends on the wording of the contract and the capability of the other approved public water supply to safely provide water to the contracted supply during consecutive days of maximum demands. A copy of the contract must be provided to the Water Bureau upon request

8. Interruption of Normal Power Service (Standby Power)

The following means may be employed when normal power service is interrupted to provide continuous supply of finished water:

a. Standby sources of energy such as natural gas, gasoline or diesel driven prime movers so that water may be treated and/or pumped to the distribution system. The standby capacity should be able to provide an amount of water equal to average day demands. For water systems with hydropneumatic storage, automatic switch gear is recommended for those systems that rely on a generator or another sub-station for backup power

b. Elevated storage capacity equal to or greater than <u>two</u> days of average day demands.

c. A connection to another approved water supply with adequate auxiliary power and sufficient capacity to meet maximum day demands.

d. A separate electrical feed from another sub-station independently routed to the plant or well house.

e. Combinations of the above.

9. Interruption in Water Service to Distribution System

Refer to the *Guidelines For Issuing Boil Water Advisories To Address Potential Microbial Contamination of Community Water Supplies* policy located in Appendix A for precautionary measures when an interruption in water service to the distribution system occurs due to a failure in the source of supply.

10. Determining Peak Instantaneous Demands

Rule 1013 of Act 399 states that pumping facilities operating with hydropneumatic storage, or with less than adequate gravity storage shall have the capacity equal to, or greater than, peak instantaneous demands. Historically, the Water Bureau has accepted the following as sufficient criteria to meet peak instantaneous demands:

a. Manufactured Housing Communities (MHCs) - 1 gpm per lot may be acceptable if in limited circumstances the water supply will only serve residential units typically having not more than 2 bathrooms and be used only for sanitary purposes without excessive water used for other purposes such as lawn sprinkling, car washing, etc.

b. Subdivisions, condominiums, apartments or other Type I supplies – 2.5 gpm per living unit.

Other methods to determine peak instantaneous demands such as the Fixture Count Method and the Residential Unit Method can be used, and will be approved by the Water Bureau on a case-by-case basis. A description of these methods is included in Appendix C.

Part 13 CONSTRUCTION PLANS, SPECIFICATIONS AND REPORTS

Applicable references

- Michigan Safe Drinking Water Act, Section 4 and Part 13,
- Recommended Standards For Water Works, Parts 1, 2 and *Policy Statement On Pre-Engineered Water Treatment Plants*
- DEQ-Water Bureau Policy, WD-03-018, *Turbidity Compliance Monitoring and Determination of Compliance With The Turbidity Treatment Technique Standard*
- Michigan Section AWWA Water System Security Guidance Document

1. Water Plant Plans – General

The design of a water supply system or treatment process encompasses a broad area. Application of specific design criteria is dependent upon the type of system or process involved.

2. Plant Site Layout

All designs shall consider hydraulic requirements and residuals disposal.

3. Building Layout

Facilities should consider security as outlined in the Michigan Section AWWA Water System Security Guidance Document, July 2002. This document is available at www.mi-awwa.org

4. Additional Required Permits

The DEQ, U.S. Corps of Engineers and any other appropriate regulating authority must be consulted regarding any structure which is so located that normal or flood stream flows may be impeded or where shipping lanes are occupied. Additional DEQ permits may be required for discharge, stormwater control, etc., as mentioned in the Permit Application for Water Supply Systems.

5. Electrical Controls – Location

Main switch gear electrical controls shall be located above grade and shall not be subject to flooding or a corrosive atmosphere.

6. Underground Electrical Service

Underground electrical service should not be used in areas below the one hundred year flood elevation or areas otherwise subject to flooding.

7. Laboratory and Equipment

Laboratory equipment and facilities shall be compatible with the raw water source, the complexity of the treatment process involved, and the requirements of the state drinking water standards.

a. Testing equipment shall be adequate for the purpose intended and recognized procedures must be utilized.

b. The location of the laboratory should consider operator convenience and accessibility with regard to the plant operations center.

8. Continuous Monitoring Equipment – Turbidity

Subpart H treatment plants must have the capacity to monitor and record turbidity of the raw and finished water. Conventional and direct filtration plants are required to monitor and record turbidity of each filter effluent once every 15 minutes. Subpart H plants should also have the ability to monitor settled water turbidity where applicable.

Plants treating groundwater using lime softening should have the capability to monitor finished water turbidity.

9. Sample Taps

In addition, in a complete treatment system, sample taps should be provided for each filter at each elevation of a media change.

10. Meters

All in-plant usage should be metered. Meters should also be installed at various points throughout the treatment train to adequately determine water volumes used and/or wasted at each treatment process.

11. Water Distribution System Plans – General

Plans for waterworks system construction and alteration shall, where pertinent, provide the following:

a. List of all utilities and contacts necessary for a construction project.

b. Upon project completion, as-built plans for all waterworks construction shall be provided to the utility and should be kept on file with the utility.

12. Permits for Alteration to a Treatment System

Prior approval must be obtained from the Water Bureau when a change or alteration to a treatment system is proposed, including:

a. Change in the type of chemical used or the chemical application point (e.g., substituting another disinfectant for chlorine or changing the point of chlorination to reduce concentrations of disinfection byproducts).

b. Addition of a new chemical, chemical feed system or treatment unit.

c. Change in composition of quality or quantity of filter media.

d. Testing of alternative coagulants for subpart H systems.

13. Letter of Transmittal

This requirement has been replaced by the Permit Application For Water Supply Systems. However, a letter should be provided if needed to request any variances from normal design standards or to explain unusual circumstances.

14. Recommended Design Standards

Design standards listed in Act 399 or Recommended Standards For Water Works must be followed. Any deviations from those standards shall be discussed and adequate justification shall be provided in writing.

15. Requesting a Deviation From Normal Design Standards

A deviation from design standards may be granted by the Water Bureau on a case by case basis upon a showing by the supplier of water that such a deviation will not adversely affect public health.

Examples of design standards for which a deviation must be requested if an alternate design is contemplated include but are not limited to the following:

a. the minimum vertical and horizontal separation maintained between water mains and sewers,
b. the standard well isolation distance,
c. placing a ground level storage tank above the highest groundwater level, etc.

All deviations need to be requested by the supplier of water and justification must be provided with the construction permit application. At a minimum, the request should include the following information:

a. the location(s) where a variance is requested,
b. a list of other design criteria that were considered or incorporated to mitigate or minimize the potential impacts of not meeting normal design standards, and
c. the notice provisions that will be used to inform field inspectors of the deviation and any conditions placed on construction in granting the deviation.

16. Replacing Water Mains and Appurtenances

For Type I public water supplies, an adequately sized water main or other appurtenance on a distribution system, which does not affect flow or capacity, is the same size, same material and is being placed in the same location as the existing main, can be replaced without a construction permit providing the present and projected demands can be met. Replacement water mains of larger or smaller diameter than the original main require an Act 399 construction permit.

The replacement of water main with one of the same size but less than 6-inch in diameter requires Water Bureau review and issuance of a construction permit except where the system has no hydrants or fire protection capability and where it is not intended to provide fire protection now or in the future.

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PART 14 CROSS CONNECTIONS

Applicable references
- Michigan Safe Drinking Water Act, Part 14
- DEQ Cross Connection Rules Manual

1. Purpose:

Type I water systems must establish and implement a routine cross connection control program to detect and eliminate cross connections in order to prevent backflow of contaminants into the public water system.

2. Approval of Cross Connection Control Ordinance

Municipal systems are required to have an ordinance that prohibits cross connections. Nonmunicipal systems do not need to establish authority by means of an ordinance, but they are expected to develop and implement a written program.

3. Approval of Written Program

Type I water systems are required to have a cross connection control program. Each program must be reviewed and approved by the Water Bureau.

4. Contents of a Cross Connection Control Program and Ordinance

The DEQ Cross Connection Rules Manual has a sample program and ordinance that water systems can use as guidelines when establishing or updating a program and/or ordinance.

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PART 16 GENERAL PLAN

Applicable references

- Michigan Safe Drinking Water Act, Part 16

1. Purpose:

To provide water system infrastructure information.

2. Acceptability of previous general plans; updating requirements.

The DEQ will require the previous general plan to be updated if there are significant water system improvements consisting of one or more of the items listed below:

a. Significant water main construction projects.

b. Creation or deletion of a pressure district.

c. Installation of a new water supply source and/or water systems.

3. Contents of general plans

In addition to the items listed in Act 399, a general plan should indicate the overflow elevation of the water storage tank with reference to the United States Geological Survey datum.

The age and pipe material should be indicated along with the size, if known.

4. Hydraulic Grade Line Profile

A water system that employs complete treatment and/or has pressure district shall upon request submit to the Water Bureau a hydraulic grade line profile of the water system.

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PART 17 OWNERSHIP OF PUBLIC WATER SUPPLIES

Applicable references

- Michigan Safe Drinking Water Act, Part 17
  DEQ Water Bureau *New Community Water System Capacity Guideline Document*

1. Purpose

The purpose of this part is to prescribe certain requirements and procedures in accordance with Act 399 for private ownership of certain Type I public water supplies when public ownership cannot be achieved.

2. Intent

Act 399 was passed with the intent of protecting public health and to assure that public water supplies and waterworks systems are properly planned, constructed, maintained, and operated.

It is a well established principle that Type I public water supplies be operated and maintained in an effective manner at all times and that adequate provision be made for a continuing administrative authority to accomplish this objective. Therefore, the Water Bureau strongly encourages that all Type I public water supplies be under the ownership and control of a Local Unit of Government (LUG). If a LUG will not accept ownership of a Type I public water supply, specific steps must be taken to assure proper operation and maintenance of that system. The following steps must be completed before the DEQ will issue a construction permit for a new, privately owned Type 1 supply:

- Obtain a resolution from the LUG indicating their refusal to own or operate the proposed public water system.
- Enter into a consent agreement (Rule 1713 consent order) with the Water Bureau stipulating the manner in which the system will be constructed, operated and maintained.
- Establish a continuing, cash escrow fund available only to the Water Bureau for emergency repairs or maintenance. A letter of credit, savings account or certificates of deposit are all acceptable fund formats.
- Obtain easements for portions of the waterworks system not located in the public right-of-way, including the well isolation area, which will be used in the operation of the system.
- Demonstrate clear ownership of all facilities necessary for operation of the system.

The above steps are outlined in the DEQ Water Bureau's New Community Water System Capacity Guideline Document which is available on the DEQ website at http://www.michigan.gov/deq.

PART 19 EXAMINATION AND CERTIFICATION OF OPERATORS

Applicable references

- Michigan Safe Drinking Water Act, Part 19
- DEQ-Water Bureau Policy, DWRP-03-017, *Community Water Supply Systems, Required Operations Oversight*

1. Change in Classification

The Water Bureau may change (raise or lower) the classification of a treatment system or distribution system for several reasons:

a. Treatment Systems

i) Special design features making operation more difficult or complex;

ii) The raw water quality makes the water particularly difficult to treat or the rapid changes in raw water quality require greater operator skill;

iii) Because of decreasing populations, decreasing water use or other reasons, the design treatment capacity may be in excess of current needs. If the treatment rate is still approaching design capacity during reduced hours of operation, the classification may remain unchanged.

b. Distribution Systems

i) Hydraulically complex systems, such as those having multiple pressure districts, several distribution system booster pumping stations and storage tanks; or

ii) A very limited distribution system consisting mostly of building plumbing without hydrants.

2. Certification of Shift Operators

Many complete treatment plants employ relief operators who are routinely in charge of one or more shifts per week. Such operators might cover vacation leave, sick leave, or holidays where the normal shift operators are absent. Such operators are required to have the appropriate F certificate.

3. Operator Trainee

a. Preferably a supplier of water should replace a certified shift operator with one that has already obtained the proper certification. If this is not possible, the supplier of water should provide notice to the Water Bureau when an operator trainee is designated to operate a plant shift.

b. The operator trainee should submit an application for the next written examination, and if the minimum qualifications are not met, the Water Bureau shall notify the supplier of water immediately.

c. The supplier of water should only appoint operator trainees qualified to become certified, but in the event the Water Bureau determines the operator trainee is not qualified, the supplier of water shall take immediate action to fill the position with a qualified operator.

d. The Water Bureau will not allow the appointment of an operator trainee for more than 2 years, and if the operator trainee cannot achieve the certification required, the supplier of water must provide a certified replacement. The Water Bureau will carefully review the necessity for repetitive replacements of operator trainees and will ultimately require the supplier of water to seek a properly certified operator to fill the vacancy.

4. Operator Supervision

Consistent with the *Community Water Supply Systems, Required Operations Oversight* policy located in Appendix A, water treatment and distribution systems are required to be under the supervision of an operator-in-charge certified at the appropriate classification and level.

5. Contract Operations

Contract operation as the standard mode of operation as defined in the *Community Water Supply Systems, Required Operations Oversight* policy for a water treatment and distribution systems is acceptable.

PART 23 CONTINGENCY PLANS

Applicable references

- Michigan Safe Drinking Water Act, Part 23
- AWWA Manual *M19, Emergency Planning For Water Utilities*
- DEQ-Water Bureau Policy, WB-014, *Guidelines For Issuing Boil Water Advisories To Address Potential Microbial Contamination of Community Water Supplies*

1. Purpose

To establish requirements of Type I public water supplies to prepare a contingency plan in accordance with Act 399

2. Type of Emergencies

The types of emergencies which a supplier of water may consider when preparing a contingency plan include, but are not limited to one or more of the following events:

a. Severe weather including tornadoes, lightning, snow or ice storms,

b. Floods, including that caused by equipment (pipes/pumps) within a plant,

c. Water main breaks at critical locations,

d. Strikes and walkouts of employees,

e. Chemical spills or other contamination in or near the source of supply,

f. Backflow of contaminants into a waterworks system,

g. Destruction by vandalism, civil disorder, sabotage, or malevolent acts,

h. Shortage of critical treatment chemicals due to work stoppages by manufacturers and distributors or other reasons,

i. Power outages,

j. Freezing of source of supply, stoppage of intake, or freezing of storage tank(s),

k. Enemy attack in case of war or terrorism,

l. Introduction of contaminants into the distribution system, storage tanks, intakes, and treatment plants by trespassers and vandals,

m. Shore and beach erosion, and

n. Contamination of the plant or source of water by radiological contaminants.

3. Inventory

The contingency plan should contain an inventory of necessary standby personnel, operating and testing equipment, chemicals, and other materials from within the waterworks system and related departments. Additionally the plan should have general information about other waterworks systems in the general region.

4. Public Notification

When notification of known or potential microbiological contamination is given to water system customers, appropriate instructions for boiling or chlorinating small amounts of water for drinking should be included. When such treatment will not eliminate the contamination and render the water safe and potable, information should be provided about body contact and/or suitability of water for other uses. Other methods for customers to obtain safe water shall be furnished. Such emergency means may include bottled water, hauling or piping water from a safe source.

5. Boiling or Chlorinating Small Amounts of Water for Drinking

Refer to the *Guidelines For Issuing Boil Water Advisories To Address Potential Microbial Contamination of Community Water Supplies* policy in Appendix A for water precautionary measures

6. Isolation of Damaged Areas

The contingency plan shall include a provision and procedure for isolating damaged areas where the emergency precludes immediate use of the water supply. A plan shall be included for closing service connections for houses and other buildings which have been damaged or lost during a disaster such as a tornado.

7. Critical Customer List

A list of critical customers or users requiring a continuous supply of safe water would include but not be limited to:

a. Hospitals, clinics,

b. Dialysis facilities,

c. Nursing homes and other care facilities,

d. Critical manufacturing and process industries where lack of water or chlorinated water could result in costly damage to equipment, facilities, fish hatcheries, etc., and

e. Emergency housing and medical treatment centers used during emergencies and disasters.

8. State Emergency Plan

The supplier of water should be aware that a state emergency plan is in existence. By order of the Governor, this plan is executed by the Emergency Services Division of the Department of State Police. The emergency plan has a provision for public water supplies into which the Department of Environmental Quality executes and assumes certain responsibilities.

9. Utility Emergency Response Plan

The supplier of water should also address security concerns as noted in Public Law 107-188, the Bioterrorism Act of 2002. Utilities with service populations greater than 3,300 and some with smaller service populations were required to conduct a Vulnerability Assessment and submit an Emergency Response Plan (VA/ERP) to identify and address security concerns. Listed below are some of the security enhancement items a utility should consider under the Bioterrorism Act:

a. installation of equipment for detection of intruders;

b. installation of fencing, gating, lighting, or security cameras;

c. the tamper-proofing of manhole covers, fire hydrants, and valve boxes;

d. the re-keying of doors and locks;

e. improvements to electronic, computer, or other automated systems and remote security systems;

f. participation in training programs, table top exercises, and the purchase of training manuals and guidance materials relating to security against terrorist attacks;

g. improvements in the use, storage, and/or handling of various chemicals; and

h. security screening of employees or contractor support services.

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Appendix A

DEQ Policies and Procedures

DWRP-03-002	*Permit Requirements For Water Main Construction*
DWRP-03-016	*Grouting of Community Water Supply Wells*
DWRP-03-017	*Community Water Supply Systems, Required Operations Oversight*
WD-03-003	*Aquifer Test Requirements For Public Water Supply Wells*
WD-03-018	*Turbidity Compliance Monitoring and Determination of Compliance With The Turbidity Treatment Technique Standard*
WD-03-020	*Design and Operational Requirements For Arsenic Removal Treatment Systems For Compliance With The Arsenic MCL*
WB-012	*Disposal of Backwash Water From Arsenic Removal Units*
WB-013	*Classification of Public Water Supplies*
WB-014	*Guidelines For Issuing Boil Water Advisories To Address Potential Microbial Contamination of Community Water Supplies*

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DRINKING WATER AND RADIOLOGICAL PROTECTION DIVISION
POLICY AND PROCEDURES

NUMBER:	DWRP-03-002	
SUBJECT:	PERMIT REQUIREMENTS FOR WATER MAIN CONSTRUCTION	
EFFECTIVE DATE:	JUNE 19, 1997	

ISSUE:

The definitions and requirements for water main, customer site piping, and service connection established under the authority of 1976 PA 399 are confusing to water suppliers. As such, the department has previously issued construction permits for numerous piping systems which were not under its jurisdiction.

DEFINITIONS:

1. 325.1002. Sec. 2 (d) - "Customer service connection" means the pipe between a water main and customer site piping or building plumbing system.

2. 325.1002. Sec. 2 (e) - "Customer site piping" means an underground piping system owned or controlled by the customer that conveys water from the customer service connection to building plumbing systems and other points of use on lands owned or controlled by the customer. Customer site piping does not include any system that incorporates treatment to protect the public health.

3. 325.1002. Sec. 2 (o) - "Public water supply" means a waterworks system that provides water for drinking or household purposes to persons other than the supplier of water, and does not include either of the following:

   (i) A waterworks system that supplies water to only one living unit.
   (ii) A waterworks system that supplies water only to customer site piping.

4. 325.1002. Sec. 2 (q) - "Service connection" means a direct connection from a distribution water main to a living unit or other site to provide water for drinking or household purposes.

5. 325.1002. Sec. 2 (r) - "Supplier of water" or "supplier" means a person who owns or operates a public water supply, and includes a water hauler.

6. 325.1002. Sec. 2 (u) - "Water main" means a pipe owned or controlled by a supplier that may convey water to a customer service connection or to a fire hydrant.

7. R 325.10103 (s) - "Customer service connection" means the pipe between a water main and customer site piping or building plumbing system.

8. R 325.10108 (b) - "Service connection" means a direct connection from a distribution water main to a living unit or other facility for the purpose of providing water for drinking or household purposes. A service connection is not designed to be an integral part of the network of distribution water mains.

RULES AND REGULATIONS:

1. 325.1004. Sec. 4 (3) states in part - Before commencing the construction of a waterworks system or an alteration, addition, or improvement to a system, a supplier of water shall submit the plans and specifications for the improvements to the department and secure from the department a permit for construction of the same…

2. 325.1005. Sec. 5a (1) - A supplier of water for a community supply shall not use customer site piping as a means to convey water to other portions of the supplier's system.

3. 325.1005. Sec. 5a (2) - A supplier of water shall not provide water service to customer site piping if an impact on the water quality of the public water supply has occurred or could reasonably be expected to occur as a result of the service. A supplier of water may discontinue water service to customer site piping as the supplier of water or the department considers necessary to protect the health of the public water supply customers.

POLICY:

1. Piping definitions contained in the Michigan Safe Drinking Water Act for "water main", "customer site piping", and "service connection", indicate that these are mutually exclusive terms. As such, piping cannot be both water main and customer site piping, or water main and service connection, at the same time.

2. Construction permit(s):

   a) for water main must be issued to the supplier of water, even if the water main will not be owned by the supplier.

   b) must be issued for improvements to the waterworks system. Water main is part of the waterworks system and construction of water main improvements requires a permit from the department prior to commencing that construction. Customer site piping, service connections, and building plumbing are not part of the waterworks system and do not require permits from the department. These piping systems are not under the jurisdiction of the department, but rather, state and local plumbing codes. They may require permits from other agencies.

   c) applications shall contain a statement from the supplier indicating their intent to own or control the piping for which a permit is requested.

d) applications for installation on private property shall contain a statement from the supplier indicating the method of control. Specifically, if the water main on private property is to be owned by the supplier, the permit application must contain a statement indicating the supplier's intent to obtain and record suitable easements. If the water main is not to be owned by the supplier, the permit application must contain a statement indicating the supplier's intent to obtain and execute suitable utility agreements. The department may require copies of easements or agreements prior to issuing construction permits.

3. Water main:

   a) must be owned or controlled by the supplier of water.

   b) may convey water to any part of the supplier's system for any number of uses, including, but not limited to, service connections and fire hydrants.

   c) ownership is strongly encouraged by the department as the preferred method to assure long-term control of the water main.

   d) easements must be executed for all supplier owned water main located on private property.

   e) maintenance agreements must be in force between the water supplier and the owner of water main installed on private property where ownership of the main is not possible. The agreements are subject to department review to assure utility control of the privately owned water main is adequate.

4. Customer site piping:

   a) may be used to convey water from one part of a customer's system to another part of a customer's system for any number of uses, including, but not limited to, service connections and fire hydrants.

   b) may not be owned or controlled by the supplier of water.

   c) may not convey water from one part of a supplier's system to other parts of the supplier's system. As a practical application of this principle, customer site piping systems cannot be designed for flow through. If there is more than one service connection from the water main to a customer site piping system, adequate backflow prevention in accordance with an approved local cross connection program must be installed on all service connections. Backflow protection may be required on single service connections between the water main and customer site piping systems. Because permits are not required from the department for customer site piping, the responsibility to ensure appropriate cross connection control remains with the water supplier.

d) may not incorporate treatment to protect the public health.

e) is not applicable to mobile home park distribution systems. A construction permit for the distribution system installation in mobile home parks is issued under a separate program (1987 PA 96 and 1978 PA 368).

5. Service connections may be used to convey water directly from the water main to customer site piping or directly from the water main to building plumbing. The water conveyed may be used for a number of purposes, including, but not limited to, drinking water, domestic and industrial water, and fire suppression systems (not to include fire hydrants).

6. Fire hydrants that are improperly maintained and operated may adversely impact pressures and water quality in the waterworks system. Because of this, water suppliers are encouraged to maintain ownership or control of all piping systems that contain fire hydrants. When piping that supplies fire hydrants is not maintained or controlled by the water supplier, backflow prevention should be considered.

7. This policy does not encumber water suppliers to retroactively obtain easements or utility agreements for projects previously permitted by the department that were not under its jurisdiction.

PROCEDURE:

Responsibility		**Action**
DEQ Employee	1.	Construction permits will be issued to suppliers of water for water main construction after determining the plans and application information are adequate.
	2.	Plans and permit applications which are inadequate in design or application information will be returned to sender.
	3.	Plans and permit applications for piping systems which are not under the jurisdiction of the department will be returned to sender.

Water Supplier

4. A permit shall be obtained from the department for water main construction prior to commencing installation of the water main.

5. Application for a water main construction permit shall contain a statement from the supplier indicating their intent to own or control the piping for which a permit is requested.

6. Application for a water main construction permit on private property shall contain a statement from the supplier indicating the method of control.

7. Suppliers of water must ensure appropriate cross connection control between their water main and all piping systems that do not meet the water main definition.

APPROVED: Flint C Watt DATE: 6/18/97

Flint C. Watt, P.E., Chief
Drinking Water and Radiological Protection Division

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DEQ

DRINKING WATER AND RADIOLOGICAL PROTECTION DIVISION
POLICY AND PROCEDURES

NUMBER:	DWRP-03-016	
SUBJECT:	GROUTING OF COMMUNITY WATER SUPPLY WELLS	
EFFECTIVE DATE:	DECEMBER 27, 2000	PAGE: 1 OF 3

ISSUE:

The Groundwater Quality Control Rules, adopted pursuant to Section 12714 of Part 127, Water Supply and Sewer Systems, of the Public Health Code, 1978 PA 368, as amended (Act 368), contain provisions for sealing the annular space surrounding a well casing with grout to prevent well contamination and degradation of ground water quality. Rule 822 (R 325.10822) and Rule 832 (R 325.10832) of Part 8 of the administrative rules adopted pursuant to Section 5, MCL 325.1005, of the Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), contain provisions for grouting public water supply wells by a method approved by the Department of Environmental Quality (DEQ). This policy and procedure outlines the approved casing grouting methods for water supply wells and test wells associated with community water supplies (CWSs).

DEFINITIONS:

Community Water Supply – A public water supply which provides year-round service to not less than 15 living units or which regularly provides year-round service to not less than 25 residents. Examples include municipalities, such as cities, villages, and townships; apartment complexes; manufactured housing communities; condominiums; and nursing homes.

Production Well – A well that has been approved for use as a water supply well to serve a CWS in accordance with the provisions of Part 8 of the administrative rules adopted under Act 399.

State Well Construction Code (SWCC) – The administrative rules promulgated pursuant to Section 12714 of Act 368, being R 325.1601 through R 325.1781 of the Michigan Administrative Code.

Test Well – A well that is used to obtain information on ground water quantity, quality, or aquifer characteristics for the purpose of designing or operating a CWS well (i.e., observation well).

POLICY:

The following criteria apply to production wells and test wells that are located within the approved standard isolation area surrounding the completed production well:

1. New production wells or test wells shall be grouted with neat cement, neat cement/bentonite admixture, or concrete grout pursuant to the provisions of the SWCC (copy attached).

2. The Drinking Water and Radiological Protection Division's (DWRPD's) District Engineer may allow the use of bentonite grouts on production wells and test wells where the pumping rate of the permanent pump installed in the production well is to be less than 100 gallons per minute.

3. Production wells or test wells that are flowing (artesian), or that discharge subterranean gases, shall be grouted with neat cement, neat cement/bentonite admixture, or concrete grout.

4. The DWRPD may allow the use of low heat-of-hydration cement (ASTM Type IV) for grouting production wells or test wells constructed with PVC plastic well casing.

   Note: Where low heat-of-hydration cement is not used and the borehole is over 4 inches larger than the nominal casing size, PVC plastic well casing with a standard dimension ratio (SDR) of 17 is recommended. The risk of casing distortion or collapse due to increased temperature from the heat-of-hydration cement is low. However, SDR 17 PVC plastic well casing provides added protection due to its thicker wall and greater resistance to hydraulic collapse. The hydraulic collapse pressure for SDR 17 pipe is 224 pounds per square inch (psi), compared to 115 psi for SDR 21 pipe.

5. Requests to use cement grout additives or admixtures other than that specified in the SWCC shall be submitted for review to the District Engineer and shall be approved before use.

6. All production wells and test wells shall be grouted pursuant to the provisions of the SWCC and this policy and procedure. Test wells that are not grouted pursuant to the provisions of this policy and procedure will not be approved by the District Engineer for conversion to a production well and shall be plugged in accordance with the abandoned well plugging provisions of the SWCC.

7. A test well shall not be converted to a production well if there are test wells located within the standard isolation area surrounding the proposed production well that have not been grouted pursuant to the provisions of this policy, until those test wells have been properly sealed.

PROCEDURE:

Responsibility	Action
DWRPD's District Engineer	Incorporates this policy and procedure as part of the permit to construct a CWS well and uses this policy and procedure to evaluate proposals from consulting engineers, developers, and water well drilling contractors. Plans, specifications, and/or permit applications which are inadequate or which contain criteria in conflict with the specifications contained herein will be returned to the sender. This policy and procedure replaces the Michigan Department of Public Health memorandum dated May 17, 1988 entitled "Guidelines for Grouting Type I Wells."

Responsibility	Action
CWS owner or owner's representative (e.g., consulting engineer)	Provide project oversight to ensure that the CWS meets the DEQ's regulations and permit provisions.

APPROVED: Flint Watt DATE: 12/27/00

Flint C. Watt, P.E., Chief
Drinking Water and Radiological Protection Division

Water Well Grouting Requirements

(Excerpts from Michigan Water Well Construction Code – Part 127 – 1978 PA 368, as amended)

Definitions

R 325.1601(3): "Annular space" means the space between 2 cylindrical objects, 1 of which surrounds the other, such as the space between a borehole wall and a permanent casing or between a temporary casing and a permanent casing.

R 325.1601a(3): "Bentonite" means a plastic, colloidal clay which has an extensive ability to absorb fresh water and swell in volume and which is composed predominately of the mineral montmorillonite.

R 325.1601a(4): "Bentonite chips" means bentonite that is crushed to an approximate size range of 3/8 to ¾ of an inch.

R 325.1601a(5): "Bentonite grout" means a slurry which consists of bentonite and water and which has a high solids concentration and a minimum density that meets specifications approved by the department. A slurry of drilling fluid bentonite and water or drilled cuttings, either singularly or in combination, is not bentonite grout.

R 325.1601a(6): "Bentonite pellets" means bentonite that has been processed into pellet or tablet form with a diameter of ¼ to ½ of an inch.

R 325.1602(3): "Concrete grout" means a mixture of cement, sand, and water in the proportion of 1 bag of cement (94 pounds), an equal volume (1 cubic foot) of dry sand or gravel aggregate, and not more than 6 gallons of clean water.

R 325.1603(2): "Granular bentonite" means bentonite that has an approximate size range of 1/32 to 1/8 of an inch.

R 325.1603(5): "Grout" means a material that has a low permeability, such as neat cement, bentonite grout, bentonite chips, bentonite pellets, granular bentonite, or other materials which have equivalent sealing properties and which are approved in writing by the department before use.

R 325.1603(6): "Grouting" means the placement of grout into the annular space that surrounds a permanent casing for the purpose of sealing the annular space to prevent the entrance or migration of surface water, near surface water, and contaminants to the groundwater and to maintain the natural protection of aquifers.

R 325.1603a(1): "Neat cement" means a mixture of 1 bag of Portland cement (94 pounds) and not more than 6 gallons of fresh water. Drilling fluid bentonite that is not more than 5% by weight of cement and additional water that is not more than 0.6 gallons for each 1% of bentonite may be added to neat cement. Other additives and admixtures shall be approved by the department before use.

R 325.1613 Deviations from minimum standards.

(f) The provisions of R 325.1634a(1) may be deviated from to permit the length of casing to be grouted for rotary-bored or augered wells to be decreased if the well is more than 100 feet deep and if a confining layer is not penetrated.

R 325.1633a Construction of wells; grouting.

Rule 133a. (1) Shale traps, cementing baskets, packers, or other devices shall not be used to suspend grout above an open annular space. Excessive development, washing, shoveling of cuttings, or other similar activities shall not be used to induce collapse of the borehole wall or to reduce the amount of open annular space surrounding a permanent casing.

(2) Neat cement or bentonite grout shall be placed through the permanent casing or a grout pipe from the bottom of the annular space upward to the ground surface in a continuous operation without interruption. The density of grout flowing from the annular space at the ground surface shall be the density of the grout being pumped in.

(3) A permanent casing shall be installed in a borehole that has a diameter of not less than 2 inches larger than the nominal size of the permanent casing, except as provided in subrule (4) of this rule and R 325.1635.

(4) When grout is placed through a grout pipe outside the permanent casing, the borehole diameter shall be not less than 2 7/8 inches larger than the nominal casing size.

(5) An annular space between a permanent casing and temporary casing shall be grouted during temporary casing removal by pumping neat cement or bentonite grout, or by pouring bentonite chips, bentonite pellets, or granular bentonite, into the annular space. Granular bentonite shall not be poured into an annular space that contains drilling fluid or water.

(6) Neat cement shall be allowed to set a minimum of 24 hours when standard type I, type Ia, or high-early type III cement is used. If bentonite is added to neat cement, the grout shall be allowed to set a minimum of 48 hours before drilling operations are resumed.

R 324.1634a Construction of wells; grouting rotary-bored or augered wells.

Rule 134a. (1) A well that is constructed by rotary, auger, or other drilling method where the permanent casing is placed in an oversized borehole shall be grouted with neat cement or bentonite grout, pursuant to the provisions of R 325.1633a, the entire length of the casing. If a well screen is installed, the annular space shall be grouted from a point not more than 10 feet above the top of the well screen up to the ground surface.

(2) The depth of grouting may be decreased by the health officer pursuant to the provisions of R 325.1613(2)(f).

R 325.1635 Construction of wells; grouting driven casing wells.

Rule 135. A well that is constructed by cable tool, hollow rod, jetting, or other drilling method where the permanent casing is driven shall be grouted pursuant to either of the following provisions:

(a) Where temporary casing or oversized borehole is not used or where the temporary casing or oversized borehole is less than 25 feet in depth, dry granular bentonite shall be maintained around the permanent casing as it is being driven.

(b) By installing a temporary casing or oversized borehole not less than 3 inches larger than the nominal size of the permanent casing and extending not less than 25 feet below the established ground surface and grouting the annular space surrounding the permanent casing pursuant to the provisions of R 325.1633a.

R 325.1637 Construction of bedrock wells.

Rule 137. (1) Where bedrock is encountered within 25 feet of the ground surface, an oversized borehole shall be drilled and the permanent casing shall be grouted with neat cement for a minimum depth of 25 feet.

(2) In an area where a well can be developed only in fractured, jointed, or cavernous bedrock, the casing may terminate in the formation if there is not less than 25 feet of soil above the bedrock, if there is no record of the bedrock containing contaminated water, and if geologic conditions offer no natural direct surface or near surface water inlets into the bedrock aquifer.

Where there is less overburden and deeper strata will not produce potable water, the well owner shall obtain written approval from the health officer for water treatment and well construction features that are necessary to provide a safe supply.

(3) Hydraulic fracturing of bedrock is not permitted without the prior written approval of the health officer.

R 325.1637a Verification of well grouting.

Rule 137a. Where the department or health officer determines that any of the following conditions exist, the well drilling contractor may be required to excavate the well head for inspection:

(a) A visible open annular space surrounding a well casing.

(b) Failure to detect, using a soil probe, excavation, geophysical logging, or other methods, grout 2 feet or more below the water service line connection to the casing.

(c) Placement of tracer dye around the casing at or near the ground surface with subsequent detection of the dye in the well water.

(d) Receipt of a well log which indicates that the well has not been grouted or which lacks information or contains incomplete information pertaining to grouting of the well.

R 325.1638 Construction of flowing artesian wells.

Rule 138. (1) A well that is constructed in a location where flowing artesian conditions are encountered or are expected to occur shall be grouted to protect the artesian aquifer, prevent erosion of overlying geologic materials, and confine the flow to within the casing.

DEQ

DRINKING WATER AND RADIOLOGICAL PROTECTION DIVISION
POLICY AND PROCEDURES

NUMBER:	DWRP-03-017	
SUBJECT:	COMMUNITY WATER SUPPLY SYSTEMS – REQUIRED OPERATIONS OVERSIGHT	
EFFECTIVE DATE:	MARCH 4, 2002	PAGE: 1 OF 5

ISSUE:

The following policy is established to define the minimum oversight acceptable for community water supplies during standard operation and/or when the operator-in-charge leaves.

DEFINITIONS:

Community Water Supply (CWS) – A public water supply that provides year-round service to not fewer than 15 living units or which regularly provides year-round service to not fewer than 25 residents. Examples include municipalities, such as cities, villages, and townships; apartment complexes; manufactured housing communities; condominiums; and nursing homes.

Operator In Charge (OIC) – A properly certified operator who is designated by the owner of a public water supply as the responsible individual in overall charge of a waterworks system, or portion of a waterworks system, who makes decisions regarding the daily operational activities of the system that will directly impact the quality or quantity of drinking water.

AUTHORITY:

- Michigan's Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), 325.1009, Section 9, "Classification of water treatment and distribution systems; advisory board of examiners; certificates of competency; supervision of water treatment and distribution systems; individuals eligible for certificate."
- R 325.11901, R 325.11902, R 325.11905, R 325.11906a, and R 325.11906b of the Administrative Rules adopted pursuant to Act 399 covering the classification of treatment systems, classification of distribution systems, certification of operators, restricted certificates for existing operators, and notices to the Department of Environmental Quality (DEQ)

BACKGROUND:

Normally, a CWS employs an OIC to provide daily oversight and involvement in the system. However, other arrangements are acceptable for some situations. If an OIC suddenly leaves (retires, quits, etc.) a CWS, the response of the Drinking Water and Radiological Protection Division (DWRPD) regarding the CWS obtaining an OIC for short-term operation needs definition to promote effective operations and consistency.

DWRPD District and Area Engineers are able to evaluate the CWS staff with respect to the following:

1. Knowledge of waterworks operation
2. Managerial qualities

3. Current job duties and level(s) of certification
4. The CWS's plan for proper operation of the waterworks system when the OIC is not available

DWRPD staff shall implement the following policy with due consideration of items 1, 2, 3, and 4, above.

GENERAL POLICY:

The following criteria are established for both standard and short-term operation of F, D, and S classified water systems:

F-1, F-2, F-3, AND F-4 SYSTEMS

STANDARD OPERATION

Under standard operation, an OIC shall be employed on a full-time basis and be involved with and responsible for the daily operation of the water treatment plant. Full-time basis is either the traditional 40-hour work week or all hours of operation if the water treatment plant operates less than that.

SHORT-TERM OPERATION

For short-term operation when an OIC is no longer available, it is acceptable to provide the CWS time to recruit a replacement or promote a staff member to fill the OIC position. **During this interim period, the CWS must retain a temporary OIC certified at the appropriate level to visit the water treatment plant daily and be responsible for its daily operation.** The following conditions also apply:

- If the CWS desires to promote a staff member to be the OIC after the staff member has achieved proper certification, this individual must first qualify to write the appropriate certification examination when it is next offered. If this individual fails the examination, the CWS must immediately pursue the hiring of a full-time OIC.

- If the CWS does not desire to promote a staff member to be the OIC, then it must immediately pursue hiring a full time OIC. The OIC must be on staff within six months.

Short-Term Operation may only be considered if ALL of the following apply:

- The OIC leaves abruptly.

- The CWS cannot or does not immediately appoint an OIC.

- Properly certified shift operators are present.

D-1, D-2, AND D-3 SYSTEMS

STANDARD OPERATION

Under standard operation, an OIC shall be available at all times and make daily visits to the treatment plant to ensure the system is operating properly and to perform/oversee required performance/quality monitoring.

SHORT-TERM OPERATION

For short-term operation when an OIC is no longer available, it is acceptable to provide the CWS time to recruit a replacement or promote a staff member to the OIC position. **During this interim period, the CWS must retain a temporary OIC certified at the appropriate level to visit the water treatment plant at least twice per week, be on call 24 hours per day, and supervise/direct staff responsible for its daily operation.** The following conditions also apply:

- If the CWS desires to promote a staff member to be the OIC after the staff member has achieved proper certification, this individual must first qualify to write the appropriate certification examination when it is next offered. If this individual fails the examination, the CWS must immediately pursue the hiring of a full-time OIC.
- If the CWS does not desire to promote a staff member to be the OIC, then it must immediately pursue hiring a full-time OIC. The OIC must be on staff within six months.

Short-Term Operation may only be considered if ALL of the following apply:

- The OIC leaves abruptly.
- The CWS cannot or does not immediately appoint an OIC.
- The CWS has an operator with acceptable knowledge/experience to conduct daily operations under the supervision of the temporary OIC.

D-4 SYSTEMS

STANDARD OPERATION

Under standard operation, an OIC shall visit the water treatment plant weekly, be on call 24 hours per day, and supervise/direct staff responsible for daily operations

SHORT-TERM OPERATION – Same as STANDARD OPERATION, above.

S-1, S-2, AND S-3 SYSTEMS

STANDARD OPERATION

Under standard operation, an OIC shall be employed and available daily to oversee records maintenance and analysis, planning, monitoring, construction, and maintenance and to supervise/direct staff responsible for daily operations.

SHORT-TERM OPERATION

For short-term operation when an OIC is no longer available, it is acceptable to provide the CWS time to recruit a replacement or promote a staff member to the OIC position. **During this interim period, the CWS must retain a temporary OIC certified at the appropriate level to visit the CWS at least twice per week, be on call 24 hours per day, and supervise/direct staff responsible for daily operations.** The following conditions also apply:

- If the CWS desires to promote a staff member to be the OIC after the staff member has achieved proper certification, this individual must first qualify to write the appropriate certification examination when it is next offered. If this individual fails the examination, the CWS must immediately pursue the hiring of a full-time OIC.
- If the CWS does not desire to promote a staff member to be the OIC, then it must immediately pursue hiring a full-time OIC. The OIC must be on staff within six months.

Short-Term Operation may only be considered if ALL of the following apply:

- The OIC leaves abruptly.
- The CWS cannot or does not immediately appoint an OIC.
- The CWS has an operator with acceptable knowledge/experience to conduct daily operations under the supervision of the temporary OIC.

S-4 SYSTEMS

STANDARD OPERATION

Under standard operation, an OIC shall be on-site twice a month to oversee record maintenance, planning, monitoring, construction, and maintenance and to supervise/direct staff responsible for daily operations.

SHORT-TERM OPERATION – Same as STANDARD OPERATION, above.

S-5 SYSTEMS

Class S-5 systems include CWSs with no treatment and a distribution system limited in extent. The following guidelines shall be used to determine if a distribution system is limited in extent:

a) Any CWS with a distribution system comprised solely of building piping.

b) Any CWS comprised of an external buried distribution system that does not include water supply appurtenances that require maintenance such as fire hydrants, system valves, blow-off assemblies, etc.

STANDARD OPERATION

Under standard operation, an OIC shall be on-site monthly to oversee record maintenance, planning, monitoring, construction, and maintenance and to supervise/direct staff responsible for daily operations.

SHORT-TERM OPERATION – Same as STANDARD OPERATION, above.

PROCEDURE:

Responsibility	**Action**
DWRPD's District or Area Engineer	1. Incorporates this policy and procedure as part of the review process to determine the adequacy of OIC oversight for a CWS.
	2. This policy and procedures replaces the Michigan Department of Public Health Policy/Procedure 1993-1, dated 2/12/93.
CWS Owner	3. Notify DWRPD District or Area Engineer of changes in the status of the OIC.

APPROVED: Flint C. Watt
Flint C. Watt, P.E., Chief
Drinking Water and Radiological Protection Division

DATE: March 4, 2002

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ISSUE:

The goal of this policy and procedure is to establish standards for the acquisition of information used in implementing sound groundwater resource management practices. The Water Division (WD) has established the following requirements and evaluation criteria for yield tests and hydrogeological assessments on wells serving public water supply systems. The requirements for a yield test are based upon widely accepted practices for conducting an aquifer test for the purpose of estimating potential yields from an aquifer and wells, characterizing the groundwater resource, and managing the groundwater resource.

POLICY AUTHORITY:

R 325.10807 (Rule 807), R 325.10809 (Rule 809), R 325.10812 (Rule 812), R 325.10813 (Rule 813), R 325.10814 (Rule 814), and R 325.10830 (Rule 830) of the administrative rules adopted under the Safe Drinking Water Act, 1976 PA 399, as amended, covering the location of wells, isolation area modification, location of wells with respect to major sources of potential contamination, studies of hydrogeological conditions by suppliers of water to Type I and Type IIa public water supplies, studies of suppliers of water of Type IIb and Type III public water supplies, and yield or performance testing requirements.

DEFINITIONS:

High Capacity Well: a well or combination of wells that is or will be equipped with a pump of 70 gallons per minute (gpm) or greater capacity intended to serve a Type I public water supply system, or a Type II or Type III public water supply system with a pump of 70 gpm or greater capacity where the projected water withdrawal is over 100,000 gallons per day average for any 30 consecutive days.

Hydrogeologic Assessment: a study of hydrogeologic conditions, including a yield test, conducted for the purpose of determining an isolation area or assessing the acceptability of a well location.

Low Capacity Well: a well or combination of wells intended to serve a Type I, Type II, or Type III public water supply system that does not meet the definition of high capacity.

Yield Test: a test completed to determine the long-term production capability and/or drawdown of an aquifer or well.

POLICY APPLICATION:

1. Yield Tests for High Capacity Wells: High capacity wells shall be subject to the requirements of this policy and procedure.

2. Yield Tests for Low Capacity Wells: The requirements of this policy and procedure may apply to a low capacity well where deemed necessary by the WD. Yield tests on low

capacity wells may be required to fulfill all or a portion of this policy and procedure as deemed necessary by the WD.

3. Hydrogeological Assessments: Yield tests conducted as part of a hydrogeologic assessment, such as those required under R325.10830 on a Type I, Type II, or Type III well or a Wellhead Protection Area delineation, shall conform to the requirements of this policy and procedure. Waiver of the requirements for a yield test shall be contingent upon the availability of information on the aquifer necessary to completing the assessment using existing sources of information.

4. Replacement of Well Capacity: The requirements of this policy and procedure may be waived where a well intended to serve an existing Type I, Type II, or Type III public water supply is being constructed for the sole purpose of replacing previously existing capacity. Waiver of the requirements shall be contingent upon the availability of existing information that fulfils the requirements and intent of this policy and procedure.

POLICY BACKGROUND:

The purpose of an aquifer test is to define aquifer hydraulic characteristics and determine the ability of the aquifer to yield water. Data from an aquifer test shall be subject to a suitable mathematical analysis to predict the effects of continuous pumping with no recharge and determine a safe withdrawal rate from the aquifer. In certain instances an aquifer test may be required to assess the effects of well interferences, determine if groundwater recharge or barrier boundaries exist, or to assess the aquifer's vulnerability to contamination.

POLICY REQUIRMENTS:

OBSERVATION WELL REQUIREMENTS – Aquifer tests shall be conducted using a minimum of two observation wells. The observation wells may consist of adjacent wells terminated in the same aquifer and not in service during the aquifer test, or wells constructed for the sole purpose of obtaining drawdown measurements during the aquifer test. Observation wells shall be completed in the same aquifer and screened at or near the depth of the production well. If the production well terminates in the bedrock, the observation wells shall terminate in the same bedrock formation at approximately the same depth and exhibit a similar interval of open borehole. It is recommended observation wells be located at distances from the production well one to five times the thickness of the aquifer and at right angles to each other. The observation wells shall be located at different distances from the production well.

LOCATION INFORMATION – Locations for all wells at the well site or used in the aquifer test (production well and observation wells) shall be obtained. Locations shall be obtained using a global positioning system and reported as latitude and longitude in degrees-minutes-seconds or in degrees to an accuracy of 0.00001 of a degree.

WATER WELL RECORDS – Water well records for all wells at the site shall be entered into Wellogic or copies of the water well records transmitted to the WD for entry into Wellogic. The water well records shall include complete and accurate location information, which at a minimum is to include the latitude and longitude of the well, the township name, township number, range number, section number, and county name where the wells are located. (Note: Transmittal of water well records to the WD does not preclude the responsibility on the part of the water well driller to retain a copy and transmit a copy of the water well record to the local health department and the owner of the well in accordance with the Michigan Water Well Construction and Pump Installation Code, Part 127 of the Public Health Code, 1978 PA 368, as amended, and the administrative rules promulgated thereunder).

STATIC WATER ELEVATIONS, GROUNDWATER GRADIENT, AND DIRECTION OF FLOW – Static water elevations shall be obtained in all wells constructed at the well site or utilized in the aquifer test. Static water elevations shall be provided in feet above mean sea level (ft AMSL) with reference to the National Geodetic Vertical Datum of 1929 or the North American Vertical Datum of 1988. Static water elevations shall be determined by surveying the top-of-casing (ft AMSL), measuring the depth from the top-of-casing to the static water level in the well, and subtracting this depth from the top-of-casing elevation to determine the static water elevation in the wells. All surveyed elevations, depth from the top-of-casing to the static water level, and static water elevations shall be reported to an accuracy of 0.01 feet.

The static water elevations shall be used to determine the groundwater gradient and the direction of groundwater flow. The gradient and direction of groundwater flow shall be determined by “triangulation,” at a minimum, on three static water elevations (one from the production well and one each from the two observation wells). Wells may be in such close proximity that obtaining an accurate groundwater gradient and direction of groundwater flow is not possible. In such instances the top-of-casing elevation, depth from the top-of-casing to the static water level, and static water elevation shall be provided.

PRIOR TO THE AQUIFER TEST – The collection of background static water levels is required to account for any natural or manmade trends in groundwater level that might impact the outcome of the aquifer test. Before beginning the aquifer test, static water level measurements shall be obtained from the production well and observation wells. Static water level measurements shall be taken at a minimum of one reading every hour for a period of time equal to at least 1/3 of the anticipated length of the aquifer test.

PUMPING RATE and DURATION – The production well shall be set up and equipped to discharge at or above the desired production rate for the duration of the aquifer test. Provisions shall be made to maintain a constant flow rate from the production well over the course of the aquifer test. Periodic measurement of the flow rate should be made to ensure a constant discharge. Water from the production well shall be discharged in a manner that will not impact water levels in the aquifer or the outcome of the aquifer test. Provisions shall be provided to control or precisely know the time and magnitude of groundwater withdrawals from the aquifer as a result of nearby large capacity wells producing from the same aquifer.

Where a production well is completed in a confined aquifer, the duration of the aquifer test shall be a minimum of 24 hours. Where hydrogeologic data suggests the aquifer is unconfined, the duration of the aquifer test shall be a minimum of 72 hours.

DRAWDOWN AND RECOVERY MEASUREMENTS – During the aquifer test, drawdown measurements shall be recorded in the production well and observation wells to an accuracy of

0.01 feet. Drawdown measurements shall be made in the production well and observation wells, at a minimum, in accordance with the following schedule:

ELAPSED TIME	MEASUREMENT FREQUENCY
0 to 10 minutes	1 per minute
10 to 20 minutes	Every 2 minutes
20 to 60 minutes	Every 5 minutes
60 to 180 minutes	Every 15 minutes
180 to 360 minutes	Every 30 minutes
360 to completion	Every 60 minutes

Upon completion of pumping, measurements of water level recovery shall be obtained from the production and observation wells for a period of time not less than 1/3 the length of the period of pumping. During recovery, measurements shall be made in accordance with the schedule as noted above for drawdown measurements.

The pretest, time-drawdown, and recovery data that is collected shall be provided in both hard copy and digital form to the WD. Where data has been automatically collected in digital form at a frequency greatly in excess of the aforementioned elapsed time and measurement frequency, the data shall be reduced to a reasonable and manageable size and form prior to submittal of the data to the WD.

ANALYSIS OF DATA – At a minimum, the aquifer hydraulic characteristics transmissivity and storage coefficient shall be determined employing the methods of Cooper and Jacob (1946), or Theis (1935). More complex methods of analysis, including but not limited to the following, should be used where appropriate to the area hydrogeology and response of the aquifer to the withdrawal of groundwater:

Hantush and Jacob, 1955 – leaky-confined conditions
Hantush, 1960 – leaky-confined conditions
Neuman, 1972 – unconfined conditions and/or delayed yield
Neuman, 1974 – unconfined conditions and partial penetration
Hantush, 1961 – partial penetration
Ferris, et al., 1962 – the presence of boundaries

The analysis of data shall include a prediction of the effects of 100 days pumping at the maximum pumping rate of the permanent pump. The predictions shall include the following:

③ Maximum safe withdrawal rate for the production well.
③ Projected drawdown in the production well (corrected for well losses where necessary).
③ Projected drawdown throughout the aquifer (i.e., distance-drawdown or plan view).

References:

Cooper, H.H., Jr., and C.E. Jacob, 1946. *A generalized graphical method for evaluating formation constants and summarizing well field history*, Transactions of the American Geophysical Union, Vol. 27, pp. 526-534.

Ferris, J.G., D.B. Knowles, R.H. Brown, and R.W. Stallman, 1962. *Theory of Aquifer Tests,* Ground-Water Hydraulics, Geological Survey Water-Supply Paper 1536-E, p. 174.

Hantush, M.S. and C.E. Jacob, 1955. *Non-steady radial flow in an infinite leaky aquifer,* Transactions of the American Geophysical Union, Vol. 36, pp. 95-100.

Hantush, M.S., 1960. *Modification of the theory of leaky aquifers,* Journal of Geophysical Research, Vol. 65, No. 11, pp. 3713-3725.

Hantush, M.S., 1961. *Drawdown around a partially penetrating well,* Journal of Hydraulic Division, Proceeding of the American Society of Civil Engineers, Vol. 87(HY4), pp. 83-98.

Neuman, S.P., 1972. *Theory of flow in unconfined aquifers considering delayed response of the watertable*, Water Resources Research, Vol. 11, pp. 1031-1045.

Neuman, S.P., 1974. *Effect of partial penetration on flow in unconfined aquifers considering delayed gravity response*, Water Resources Research, Vol. 10, No. 2, pp. 303-312.

Theis, C.V., 1935. *The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage*, Transactions of the American Geophysical Union, Vol. 16, pp. 519-524.

PROCEDURE:

Responsibility	**Actions**
WD, Field Operations Section Staff, Groundwater Section, Noncommunity Unit Staff, or Environmental Health Section Staff	Convey the aquifer test requirements to the public water supply system owner or the owner's designated representative as part of the well permit process. Assure compliance with the policy and procedure upon submittal of reports to the WD. Assure accuracy of location information on water well records and entry of same information in Wellogic. Provide justification for any deviation from requirements of this policy and procedure.

APPROVED: Richard A. Powers (signature) DATE: 4/14/04
Richard A. Powers, Chief
Water Division

DEQ

WATER DIVISION
POLICY AND PROCEDURES

NUMBER:	WD-03-018
SUBJECT:	TURBIDITY COMPLIANCE MONITORING AND DETERMINATION OF COMPLIANCE WITH THE TURBIDITY TREATMENT TECHNIQUE STANDARD
EFFECTIVE DATE:	OCTOBER, 2002 PAGE: 1 OF 5

ISSUE:

The following policy is established to define compliance with the turbidity treatment technique standard and the procedure for determining compliance with the turbidity standards from the combined filter effluent points. This policy will also establish procedures defining turbidity performance requirements for individual filters.

DEFINITIONS:

Combined Filter Effluent (CFE) – filtered water effluent prior to the entry into a reservoir.

Nephelometric Turbidity Unit (NTU) – standard unit of measurement for turbidity.

Water Plant – for the purpose of this policy, "water plant(s)" refers to any water treatment plant that uses surface water and/or ground water under the direct influence of surface water as a source of water.

Surface Water Treatment Rule (SWTR) – applies to all water plants. Sets CFE turbidity standards at less than or equal to 0.5 NTU in 95 percent of the monthly samples and no one sample can be above 5 NTU for conventional, direct and membrane filtration water plants. For slow sand or diatomaceous earth (DE) plants, the CFE turbidity standards are less than or equal to 1 NTU in 95 percent of the monthly samples and no one sample can be above 5 NTU.

Interim Enhanced Surface Water Treatment Rule (IESWTR) – applies to water plants serving a population of greater than or equal to 10,000. Sets CFE turbidity standards at less than or equal to 0.3 NTU in 95 percent of the monthly samples and no one sample can be above 1 NTU for conventional, direct and membrane filtration water plants. For slow sand or DE plants, there is no change from the SWTR turbidity requirements. This rule went into effect January 1, 2002.

Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) - applies to water plants serving a population less than 10,000. Sets CFE turbidity standards at less than or equal to 0.3 NTU in 95 percent of the monthly samples and no one sample can be above 1 NTU for conventional, direct and membrane filtration water plants. For slow sand or DE plants, there is no change from the SWTR turbidity requirements. This rule goes into effect January 14, 2005.

Normalized – to cause to conform to a norm or standard.

Time Weighted Average – is an averaging technique used to calculate the concentration of a substance when consecutive individual measurements are taken at different durations of time.

AUTHORITY:

R 325.10605 (Rule 605), R 325.10720 (Rule 720), and R 325.11004 (Rule 1004) of the Administrative Rules adopted under the Safe Drinking Water Act, 1976 PA 399, as amended, covering turbidity monitoring at surface water treatment plants or ground water under the direct influence of surface water treatment plants operated by public water supplies.

BACKGROUND:

The SWTR, the IESWTR and the LT1ESWTR require water plants that use surface water or ground water under the direct influence of surface water as a source of water to monitor for turbidity at various locations and frequencies. These rules also require plants to collect and analyze a sample for turbidity from the CFE point(s) once every four hours or less when the plant is operating.

The IESWTR and the LT1ESWTR also require conventional and direct filtration plants to collect and analyze a sample for turbidity from each filter once every 15 minutes when the filter is in service. If a plant has two or fewer filters, data obtained from the CFE point can be used in lieu of individual filter samples.

It is the intent of the Michigan Department of Environmental Quality, Water Division to encourage increased monitoring by surface water treatment plants during periods of high raw, applied, or filtered water turbidities. The results from the extra samples provide more information to determine the seriousness of the event, and the effectiveness of the water treatment plant processes.

This policy requires the use of normalized data in determining compliance with the standard. The policy will prevent a water plant from being considered in violation of the turbidity standard when extra samples are collected during excursions above the standard. Also, the policy will not allow the collection of extra samples during periods of lower turbidities to lower the overall percentage of samples that exceed the standard.

POLICY:

Combined Filter Effluent Point Sampling and Compliance Determination

Water plants are encouraged to collect all samples at **uniform** intervals, throughout the entire operating period. During any episode of increased raw, applied, or filtered water turbidities, increased monitoring may be warranted, and these samples should also be collected at uniform time intervals. The filtered water turbidity readings used for reporting purposes must be collected at the CFE point prior to the entry into a reservoir. In situations where there may be more than one CFE point prior to the entry into a reservoir, each confluence point shall be separately monitored at the same uniform intervals. **Monthly Operation Reports (MORs) must report each CFE monitoring location separately**. Plant tap turbidity measurements are encouraged but will not be used for determining compliance.

Compliance with the turbidity treatment technique standard will be determined for **each CFE** using the **time weighted average** filtered water turbidity values for each four hours or less for which the treatment facility was operating. If a plant is going to use a compliance period of less than four hours, it must inform the DEQ. All filtered water turbidity readings taken from each CFE shall be recorded and used in calculating the **time weighted average** value for each four hours or less of operation. Turbidity readings when the treatment plant is off-line will not be used in determining compliance, or in the calculation of the daily or four hour compliance period turbidity values. Refer to the example calculations attached in the back of this policy.

Readings from continuous recording turbidimeters may substitute for grab sample monitoring on each CFE if the equipment is properly calibrated. However, this practice is not encouraged. If measurements from a continuous recording turbidimeter are used for compliance monitoring, compliance will be based on the **time weighted average** value for **each CFE** from all turbidity readings for each four hour period or less of operation.

For each **CFE monitoring location**, the daily average turbidity, the daily maximum turbidity, the total number of samples collected and the total number of samples with a turbidity greater than 0.3 NTU, (0.5 NTU for slow sand and DE filtration plants) shall be reported in the monthly operation report for a water treatment plant. The operation report shall be forwarded to the Water Division no later than 10 days following the month for which the report was prepared.

If a single measurement is greater than 1 NTU for conventional, direct filtration, softening or membrane plants the public water supply must notify the division as soon as possible, but not later than 24 hours after the exceedance is known. If a single measurement is greater than 5 NTU for slow sand or DE plants the public water supply must notify the division as soon as possible, but within 24 hours.

Any water plant needing assistance in calculating compliance values, or disputing a violation of the treatment technique standard, will submit copies of the daily bench sheets (or computer data logs) with all the recorded turbidity readings. The division shall use the individual readings to calculate compliance with the standard. If the results from a continuous recording turbidimeter are used for reporting purposes, plants shall make available to the division on request all records pertaining to the turbidity measurements. The plants shall provide the means for the division to review information stored on the computer data base.

Compliance will be based on at least 95 percent of all four hours or less normalized reporting periods being less than or equal to 0.3 NTU (0.5 NTU for slow sand and DE filtration plants).

<u>Individual Filter Sampling and Compliance Determination</u>

The IESWTR and the LT1ESWTR require **only conventional or direct filtration** plants that use surface water or ground water under the direct influence of surface water as a source of water to collect and analyze a sample for turbidity from each filter every 15 minutes when the filter is in service. If a plant has two or fewer filters, data obtained from the CFE point can be used in lieu of individual filter samples.

If there is a failure in the continuous monitoring equipment, plants serving a population of 10,000 or greater must conduct grab sampling every four hours, but for no more than 5 working days. Plants serving a population of less than 10,000 people must also conduct grab samples every four hours if the continuous monitoring equipment fails, but for no more than 14 working days.

Plants are strongly encouraged to have backup equipment and parts readily available. This includes not only having backup turbidimeters, but backup computers, as well. Also, plants are encouraged to backup all turbidity data daily.

Individual filter monitoring requirements are not part of the treatment technique standard. However, exceedance of certain "performance requirements" triggers other actions, and the triggers are as follows:

1) Individual filter effluent greater than 1.0 NTU for two consecutive 15 minute measurements at any time during filter operation.

2) Individual filter effluent greater than 0.5 NTU for two consecutive 15 minute measurements after the first 4 hours of operation.*

3) Individual filter effluent greater than 1.0 NTU for two consecutive 15 minute measurements at any time in 3 consecutive months.

4) Individual filter effluent greater than 2.0 NTU for two consecutive 15 minute measurements at any time in 2 consecutive months.

*Only applies to plants serving a population of 10,000 or greater. Also, this trigger only applies to the 15 minute readings taken at 4 hours and 4 hours and 15 minutes after the filter has been in operation. Any measurements taken before or after these times will not be taken into consideration for this trigger.

For operational purposes, some plants may wish to set the individual filter turbidimeters to record the turbidity more frequent than every 15 minutes. Only the turbidity measurements taken at the 15 minute intervals will be used to determine if a trigger has been exceeded.

As an example, a plant supervisor decides to record the turbidities from all individual filters every 5 minutes. Once a filter is producing water, the turbidity measurements will be measured and recorded every 5 minutes. Only the turbidity levels recorded at the 15 minute intervals (15 min., 30 min., 45 min., 60 min., 75 min., etc.) will be used to determine if a trigger has been exceeded. The readings taken at the other 5 minutes intervals (5 min., 10 min., 20 min., 25 min., 35 min., 40 min., etc.) will only be used for operational purposes and will not be used to determine if a trigger has been exceeded.

If a trigger is exceeded, the supply must report it to the DEQ on the Monthly Operation Report and include the date(s), filter number, and turbidity measurements. Supplies are required to be able to track these numbers over a three month period and retain all the individual filter turbidity records for 3 years.

PROCEDURE:

Responsibility	Action
WD's District Staff	Incorporate this policy and procedure as part of the MOR review process to determine compliance with Act 399. This policy and procedure replaces the DEQ Policy/Procedure 1996-3 dated 7/1/96.
CWS Owner	Conduct turbidity monitoring from all combined filter effluent's plus individual filters and submit the data to WD on the MOR's.

APPROVED: ______________________ DATE: 12/9/02
Richard A. Powers, Chief
Water Division

Example No. 1 - Supply determines to use a compliance period of four (4) hours for reporting purposes and collects a grab sample or reads the continuous recording turbidimeter at the CFE every four hours (plants operates 24 hours a day).

Time	CFE NTU	Time weighted 4 hr average
12:00 AM	0.13	0.13
4:00 AM	0.05	0.05
8:00 AM	0.07	0.07
12:00 PM	0.18	0.18
4:00 PM	0.11	0.11
8:00 PM	0.09	0.09
new day		

The time weighted average in this case is the actual measurement of the grab sample since there was only one sample collected during each 4 hour period.

Add the six readings from the last column, divide by 6 to get NTU = 0.105, or rounding off = **0.1 NTU**

0.1 NTU is the number to be entered on the MOR for that day.

Example No. 2 - same as Example No. 1 only the supply collects a grab sample or reads the continuous recording turbidimeter at the CFE every **hour**.

Time	CFE NTU	Time weighted 4 hr average
12:00 AM	0.12	
1:00 AM	0.09	
2:00 AM	0.11	
3:00 AM	0.21	0.13
4:00 AM	0.09	
5:00 AM	0.17	
6:00 AM	0.22	
7:00 AM	0.19	0.17
8:00 AM	0.14	
9:00 AM	0.12	
10:00 AM	0.09	
11:00 AM	0.11	0.11
12:00 PM	0.08	
1:00 PM	0.23	
2:00 PM	0.16	
3:00 PM	0.09	0.14
4:00 PM	0.05	
5:00 PM	0.15	
6:00 PM	0.17	
7:00 PM	0.09	0.11
8:00 PM	0.11	
9:00 PM	0.13	
10:00 PM	0.18	
11:00 PM	0.07	0.12
new day		

The time weighted average in this case is the average of the hourly measurements in each 4 hour compliance period since they were collected at equal time intervals (1 hour).

Add the six readings from the last column, divide by 6 to get NTU = 0.13
or rounding off = **0.1 NTU**

0.1 NTU is the number to be entered on the MOR for that day.

Example No. 3 - same as Example No. 2 only the supply experiences high raw water turbidities starting around 8:00 am until about noon. During that time, the supply collects extra grab samples from the CFE at unequal time intervals.

Below are the calculations in determining the time weighted average (TWA) during the four hour period when samples were collected at unequal time frequencies.

$$TWA = (C_1T_1 + C_2T_2 + \ldots + C_nT_n)/(T_1+T_2+ \ldots +T_n)$$

TWA = time weighted average
C = concentration of substance
T= time between measurements

Time	CFE NTU (C)	Time duration since previous measurement (T=min)	C x T
8:00	0.19	*	*
8:15	0.21	15	3.15
8:45	0.28	30	8.4
9:00	0.31	15	4.65
9:20	0.38	20	7.6
9:40	0.41	20	8.2
10:00	0.34	20	6.8
10:10	0.37	10	3.7
10:30	0.42	20	8.4
11:00	0.31	30	9.3
11:15	0.25	15	3.75
11:30	0.15	15	2.25
11:45	0.05	15	0.75
		total time = 240	**total CxT = 66.95**

TWA = 66.95/240 = **0.28** NTU. This number will then be placed in the Time weighted 4 hour average column.

The number placed on the MOR would then be the average of the six, Time weighted 4 hour average numbers similar to Example No. 2.

DEQ

WATER BUREAU
POLICY AND PROCEDURES

NUMBER:	WB-03-020
SUBJECT:	DESIGN AND OPERATIONAL REQUIREMENTS FOR ARSENIC REMOVAL TREATMENT SYSTEMS FOR COMPLIANCE WITH THE ARSENIC MCL
EFFECTIVE DATE:	OCTOBER 20, 2003 (Revision #1 – December, 2004) PAGE: 1 OF 6

ISSUE:

Effective January 23, 2006, all community water supplies and nontransient noncommunity water supplies must comply with the revised arsenic maximum contaminant level of 0.010 milligrams per liter (mg/l), or 10 parts per billion (ppb). This policy will establish design criteria to be used by Community Water Systems when designing, installing, maintaining, and monitoring an effective arsenic removal treatment system.

AUTHORITY:

R 325.10601 (Rule 601) and R 325.10604c (Rule 604c) of the Administrative Rules adopted under the Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), covering drinking water standards for specific contaminants, including inorganics, that shall be met by a supplier of water to assure the protection of the public health. In addition, Section 325.1004 (2) of Act 399 states, "Upon receipt of the plans and specifications for a proposed waterworks system, the department shall evaluate the adequacy of the proposed system to protect the public health by supplying water meeting the state drinking water standards."

DEFINITIONS:

Community Water Supply (CWS) – A public water supply that provides year-round service to not fewer than 15 living units, or that regularly provides year-round service to not fewer than 25 residents. Examples include municipalities, such as cities, villages, and townships; apartment complexes; manufactured housing communities; condominiums; and nursing homes.

Nontransient Noncommunity Water Supply (NTNCWS) – A noncommunity supply that serves not fewer than 25 of the same individuals on an average daily basis more than six months of the year. Examples include places of employment, schools, and day care centers.

Maximum Contaminant Level (MCL) – The maximum permissible level of a contaminant in water that is delivered to any user of a public water supply.

Operator In Charge (OIC) – A properly certified operator who is designated by the owner of a public water supply as the responsible individual in overall charge of a waterworks system, or portion of a waterworks system, who makes decisions regarding the daily operational activities of the system that will directly impact the quality or quantity of drinking water.

Firm Capacity - As applied to wells, pumping stations, or units of treatment systems, means the production capacity of each respective part of the water system with the largest well, pump, or treatment unit out of service.

Entry Point to the Distribution System (EPTDS) – A point where treated water enters the distribution system, after treatment and before the first customer. In most cases, this is where public water systems have to collect samples to determine compliance with the arsenic standard. For purposes of this policy, the compliance sample location will be called the "plant tap."

Point-of-Entry Treatment Device (POE) – A treatment device applied to the drinking water entering a household or building for the purpose of reducing contaminants in the drinking water throughout the house or building. These treatment devices are usually installed on the service line as it enters a building.

Point-of-Use Treatment Device (POU) – A treatment device applied to a single tap used for the purpose of reducing contaminants in the drinking water at one tap. These treatment devices are usually installed near or at the kitchen tap and are not allowed for compliance purposes for CWSs in Michigan because they are not protective of the entire household.

BACKGROUND:

The final arsenic rule was published in the Federal Register (66 FR 6976) on January 22, 2001, with an extended effective date of March 22, 2002. The rule applies to all CWSs and NTNCWSs and establishes a new arsenic MCL of 0.010 mg/l (10 ppb) that becomes enforceable on January 23, 2006, for existing systems. Also, the rule requires all new systems or systems that use a new source of water that begin operation after January 22, 2004, to demonstrate compliance with the MCL within a period of time specified by the state. It is the intent of the Michigan Department of Environmental Quality (MDEQ), Water Bureau (WB), to require any new systems or systems that use a new source of water that begin operation after January 22, 2004, to demonstrate compliance with the MCL before serving water to the public.

POLICY:

Initial Monitoring Requirements

Existing sources - The arsenic rule requires groundwater systems to sample for arsenic at each sampling point once every three years. The first compliance period starts January 1, 2005, and ends December 31, 2007. The WB is planning to require all groundwater systems to collect the first compliance sample from each sampling point during the first quarter of 2005. If the 2005 first quarter results are under 10 ppb **and** there is no other sample result from the same sampling point since January 1, 1996, equal to or over 10 ppb, the system will be determined in compliance and no further monitoring in 2005 for arsenic will be required. If the 2005 first quarter results are equal to or over 10 ppb, **or** there are other sample results from the same sampling point since January 1, 1996, equal to or over 10 ppb, quarterly monitoring must continue for the remainder of 2005. If the running annual average (RAA) after four consecutive quarters of sampling is greater than 10 ppb, the system exceeds the MCL.

Surface water systems will be required to sample annually from each sampling point and the first sample must be collected by September 30, 2006.

New sources - Each new source must comply with the 10 ppb MCL before the source begins serving water to the public. Samples collected during the pump testing of the source (well) will be used to determine initial compliance. If arsenic levels in a new source are at or below 10 ppb, the source is considered in compliance with the arsenic standard. Also, any new groundwater sources coming on-line before January 1, 2005, must begin monitoring in 2005 similar to the existing systems listed previously.

If the new source has arsenic levels over 10 ppb, the source may not serve water to the public until a properly designed treatment system, approved by the WB, is permitted and installed. After the new source (including treatment) is on-line, the EPTDS must be sampled at least quarterly. If the RAA after four consecutive quarters of sampling is at or below the MCL, the system is in compliance.

Emergency or standby sources - If a water system plans to temporarily (not intermittently) use a source of water that has no arsenic treatment system and has knowledge that the source has arsenic levels over 10 ppb (i.e., a standby or emergency well), or plans to bypass or take out of service an arsenic treatment unit that will allow water to go to the distribution system with arsenic levels over 10 ppb, the system must contact the MDEQ immediately and collect arsenic samples weekly from the plant tap or at another frequency specified by the MDEQ. Also, the system should issue a public notice to the affected water customers, preferably at the time the source is placed in service.

Compliance Calculations

For systems monitoring more than once per year, compliance with the MCL is determined by an RAA at each entry point to the distribution system or other sampling point approved by the WB. Systems monitoring annually or less frequently whose result exceeds 10 ppb must revert to quarterly sampling. Systems triggered into increased monitoring will not be considered in violation of the MCL until they have completed one year of quarterly sampling. If any sample result may cause the RAA to exceed the MCL at any sampling point (i.e., the result is greater than four times the MCL) the system is out of compliance with the MCL immediately.

Systems may not monitor more frequently than specified by the WB to determine compliance unless they have applied to and obtained approval from the WB. If a system does not collect all required samples when compliance is based on an RAA of quarterly samples, compliance will be based on the RAA of samples collected. If a sample result is less than the method detection limit, zero will be used to calculate the RAA.

The WB may require confirmation samples for any results. All confirmation samples approved to be collected by the WB within a specific monitoring period will be averaged with the original result to calculate a quarterly average. The quarterly averages will be used to determine the RAA.

If an arsenic MCL violation has occurred, the water system should contact the WB immediately and public notification will be required. A Tier 2 public notice must be issued in accordance with R 325.10403 and R 325.10405 of Act 399 as soon as possible, but no later than 30 days after the violation has occurred.

Design, Operation, Oversight and Monitoring of Arsenic Removal Treatment Systems

The design of arsenic treatment removal systems must take into consideration many factors to reliably and consistently keep arsenic concentrations below 10 ppb in the water delivered to the public. The type of treatment will depend upon the characteristics of the water to be treated, including, but not limited to, raw water arsenic concentrations, oxidation state of the arsenic in the raw water (arsenic III or V), iron levels, sulfate levels, pH, plus waste streams and backwash disposal options.

Many treatment technologies are available to remove arsenic. Treatment options consist of coagulation/filtration, coagulation assisted microfiltration, lime softening, activated alumina, ion-exchange (anion), oxidation/filtration and adsorptive/absorptive filter medias. Any emerging treatment technologies will also be considered. Water supplies planning to install an arsenic removal system may be required to run pilot studies. If a pilot study is not going to be completed, documentation must be submitted to the WB showing adequate treatment of water at other water systems using the same type of proposed treatment and having similar raw water quality.

The final design of arsenic removal systems will be based on the number and location of wells, disposal options, and the ultimate treatment technology to be used. Treatment systems may be installed in parallel, in series, and as a single pass or multiple pass configurations. The design must take into consideration that treatment systems will have to be taken out of service periodically for routine maintenance and/or repair. Below are some common types of system layouts and items that need to be taken into consideration when designing an arsenic removal system for each scenario.

Systems with several EPTDSs (i.e., two or more wells with each well located in a separate well house) -The firm capacity of the entire arsenic removal system must equal, as a minimum, the firm capacity rating of the water system. Systems are strongly encouraged to install treatment systems at each EPTDS that may exceed the 10 ppb standard. While systems are not required to have redundant treatment units at each EPTDS, the rated capacity of the treatment units at each EPTDS should equal the raw water capacity serving that particular EPTDS.

Systems with one EPTDS (i.e., two or more wells that have a common well house or one treatment plant) – As a minimum, two treatment units must be installed. The capacity of the entire arsenic removal system must equal, as a minimum, the firm capacity rating of the water system. The preferred design is to have the firm capacity of the treatment system equal the firm capacity rating of the water system. This will allow one unit to be taken out of service while the other unit(s) can remain on-line and still meet maximum day demands.

If an existing system has just one large treatment unit, and the unit is satisfactorily removing arsenic below 10 ppb, a second treatment unit will not be required until major upgrades or improvements are needed to the treatment system.

Blending Options – This option is available for systems that have some sources of water (wells) above and some below 10 ppb of arsenic, and should only be considered in unusual circumstances. This option will allow water systems to blend the water of two or more wells before entering the distribution system to keep arsenic levels less than 10 ppb. An example is blending of water from one well with arsenic of 2 ppb with water from another well with arsenic of 14 ppb. If the wells have similar pumping capacities, the resulting arsenic concentration will be 8 ppb, which will meet the new standard. The blending of water must take place prior to entering the distribution system and operational guidelines for using this option must be reviewed and approved by the WB before being implemented. Systems should be aware that by using this option, the firm capacity rating of the water systems may be decreased by the WB since two blended wells may be considered as one pumping unit in the future. Also, the system must have a valid reason for not installing treatment on the well(s) with high arsenic levels.

POUs and POEs – Due to capital and operational costs, this option should only be considered by small systems, typically less than 100 service connections. POUs are usually installed near or at the kitchen sink and are not allowed for compliance for CWSs. POEs are installed on the service line as it enters a building. POE treatment units must be owned, controlled, and maintained by the public water supply and must be equipped with alarms to indicate the unit has failed or is not operating properly. All or 100 percent of customers must participate for a system to be eligible for this option. If the American Standards National Institute/National Sanitation Foundation has issued product standards applicable to a specific type of POE treatment device, units meeting those standards shall be used. Supplies shall obtain WB approval for their POE operational oversight and monitoring plans.

Operation and Oversight - Proper operation and oversight is critical for arsenic removal systems. All systems with arsenic removal treatment units must designate an OIC and backup operator. The OIC must have, as a minimum, a limited treatment or "D" certification and provide regularly scheduled visits to the water supply in accordance with Drinking Water and Radiological Protection - Policy 03-017, Community Water Supply Systems – Required Operations Oversight.

Monitoring - Monitoring of treatment systems will be determined on a case-by-case basis at the discretion of the WB. Upon start-up, individual treatment units (i.e., each filter) should be sampled at least once per week. Over time, the weekly sampling can be reduced, eliminated or replaced with monthly plant tap monitoring with approval by the WB. Samples collected at each treatment unit effluent can be analyzed by either a certified lab or a field test kit acceptable to the WB. Compliance monitoring at each EPTDS for supplies that have arsenic removal systems will be required to sample at least quarterly, and the analyses must be done at a laboratory certified for arsenic analysis. Refer to the example sampling scenarios attached to this policy for additional guidance.

Disposal of Waste Streams – Many arsenic removal systems will have to be periodically backwashed or regenerated. Disposal of the backwash or regeneration water will depend upon the type of treatment and the characteristics of the backwash water. Disposal options include pumping to an existing sanitary sewer line, groundwater discharge or surface water discharge. Approval for ground water and/or surface water discharges may require additional permits from the MDEQ. Refer to the WB's Suggested Practices for Arsenic Residuals in Backwash Water from Arsenic Treatment Facilities for further information.

PROCEDURE:

Responsibility	Action
Water Bureau District Staff	Incorporates this policy and procedure as part of the permit process to construct arsenic treatment systems and uses this policy and procedure to evaluate proposals from consulting engineers, developers, and water systems.
	Plans, specifications, and/or permit applications for arsenic treatment systems that are inadequate in design or application information will be returned to sender.
	Review arsenic monitoring results collected by the CWS to determine compliance with the arsenic MCL.
CWS Owner	An Act 399 construction permit shall be obtained from the MDEQ for arsenic treatment systems prior to commencing installation.
	Conduct arsenic monitoring as required by the department and submit results to the WB.

APPROVED: Richard A. Powers, Chief
Water Bureau

DATE: December 6, 2004

EXAMPLES – ARSENIC REMOVAL SYSTEM DESIGN, MONITORING AND OPERATIONAL OVERSIGHT

Example No. 1 – A water supply has two wells, each 100 gallons per minute (gpm) and share a common well house (i.e., one EPTDS). Both of the wells have arsenic levels over 10 ppb. The firm capacity rating of 100 gpm is adequate to meet maximum day demands. Following the recommendation of the policy for systems with one EPTDS, the firm capacity rating of the treatment system should equal the firm capacity rating of the water system.

Design - Install three, 50 gpm treatment units (adsorptive/absorptive media, activated alumina, etc.) in parallel within the well house or two (2) 100 gpm treatment units in parallel. In the first scenario, there would be a total treatment capacity of 150 gpm and a firm capacity rating of 100 gpm. In the second scenario, there would be a total treatment capacity of 200 gpm and a firm capacity rating of 100 gpm. Both of these arrangements will allow one treatment unit to be taken out of service while still being able to meet maximum day demands.

Oversight – For D-4 systems, an OIC shall visit the water treatment facilities at least once per week. For D-1, D-2, and D-3 systems, the OIC shall visit the water treatment facilities daily. Initially, effluent from each treatment unit (filter) should be tested weekly for arsenic using a field test kit acceptable to the WB. A quarterly plant tap sample shall be collected and submitted to a state approved lab for compliance purposes. It is recommended that a split sample should be tested with the field test kit at the same time the quarterly plant tap sample is collected for verification analysis.

In the event that a test indicates the effluent from a treatment unit has an arsenic concentration of greater than 10 ppb, the treatment unit shall be taken out of service immediately and an arsenic sample shall be collected from the plant tap and submitted to a state approved laboratory for arsenic analysis. If backwashing does not return the concentration to less than 10 ppb, a service technician shall be called.

After a certain period of satisfactory operation and operator oversight, the weekly testing of each filter and quarterly sampling of the plant tap can be replaced with monthly plant tap sampling. The monthly samples must be analyzed at an approved lab and all samples will be used for compliance determinations. If monthly plant tap sampling indicates an increase in typical arsenic concentrations, sampling of each filter should resume.

Example No. 2 – A water system has fours wells (100, 200, 250, and 300 gpm) and are located in different locations within separate well houses (i.e., four EPTDS's). All of the wells have arsenic levels over 10 ppb. The firm capacity of the water system (550 gpm) is adequate to meet maximum day demands. Following the recommendation of the policy for systems with several EPTDSs, the firm capacity rating of the treatment system must equal the firm capacity rating of the water system.

Design – Install treatment units in each well house in some combination equal to the well capacity serving that particular well house. As an example, you could install three, 100 gpm treatment units or one 300 gpm unit in the well house where the 300 gpm well is located. This arrangement will allow either the largest capacity well or the largest capacity treatment unit to be taken out of service while still being able to meet maximum day demands.

Oversight – Operational oversight and sampling of each treatment unit should be the same as in Example No. 1.

Example No. 3 - A water system has fours wells (200, 250, 350, and 400 gpm) that pump to a common pipe that leads to an existing iron/arsenic treatment plant, which consists of one 1,200 gpm treatment unit (i.e., one EPTDS). All of the wells have arsenic levels over 10 ppb. The firm capacity of the wells (800 gpm) and the total capacity of the treatment plant are adequate to meet maximum day demands.

Design - Since there is only one treatment unit, the system's firm capacity rating for the treatment system is 0 gpm. This is not the preferred method of design, but will be allowed if the existing treatment system is adequately removing arsenic to below 10 ppb. When major improvements are needed to the treatment system, a minimum of two treatment units equal to the firm capacity of the system will be required.

If this is a system installing treatment for the first time, the design (at a minimum) would have to include at least two treatment units equal to the firm capacity of the well system (i.e., two 400 gpm treatment units). A more flexible design to provide better reliability would be to install four 300 gpm treatment units that would provide a treatment firm capacity of 900 gpm.

Oversight – For D-4 systems, the OIC must visit the plant weekly. For D-1, D-2, and D-3 systems, the OIC must visit the plant daily. The plant tap should be sampled weekly using a field test kit acceptable to the WB. A quarterly plant tap split sample shall be collected. One split sample should be tested with the field test kit and the other split sample should be submitted and analyzed for arsenic at a state approved laboratory for verification analysis. Sampling may be changed to monthly plant tap sampling with the monthly samples analyzed at an approved lab and all samples will be used for compliance determinations.

Example No. 4 – A water system has two wells, one well with an arsenic concentration of 2 ppb and the other with an arsenic concentration of 14 ppb. The wells have equal pumping capacities and pump to a common pipe before entering the distribution system. Therefore, the resulting arsenic concentration when both wells are operating is 8 ppb.

Design – In this case, treatment will be required to be installed on the source with arsenic levels of 14 ppb, unless waived by the WB. If a waiver is approved by the WB, the telemetry or well system controls must be set up so that both wells operate simultaneously to achieve adequate blending and dilution. Water meters or hour meters shall be installed for each well to make certain that both wells are pumping the same amount of water. Systems must be aware that eventually the well with the lower arsenic levels will be out of service, allowing only the well with an arsenic level over 10 ppb to pump water to the system.

Oversight – For D-4 systems, the OIC must visit the plant weekly. For D-1, D-2, and D-3 systems, the OIC must visit the plant daily. Both wells and the plant tap should be sampled monthly using a field test kit acceptable to the WB. The plant tap must also be sampled quarterly and submitted to a state approved lab for MCL compliance determination.

Example No. 5 – A 30-home subdivision has two wells that both have arsenic levels over 10 ppb. The homeowners have chosen to install POEs in each home to comply with the arsenic MCL. All 30 homeowners have agreed to participate.

Design – The POEs must be installed on the service lines entering the homes and all units must be owned, controlled, and maintained by the owner of the water system (homeowners association, developer, private utility company, etc.). All treatment units must have alarms indicating that the unit is not working properly or has reached its maximum design life.

Oversight – Since this is a D-4 system, the OIC must visit the water system weekly. Approximately 10 percent of the treatment units shall be sampled quarterly and submitted to a state approved lab. The quarterly sampling should be rotated among the homes so that every unit is sampled at least once every three years.

If any sample result exceeds 10 ppb, a confirmation sample must be collected from the same location as soon as possible. If the confirmation sample also exceeds 10 ppb, that particular treatment unit must be replaced or repaired immediately and all other units must be scheduled for repair or replacement as soon as possible.

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NUMBER:	WB-012
SUBJECT:	DISPOSAL OF BACKWASH WATER FROM ARSENIC REMOVAL UNITS
EFFECTIVE DATE:	OCTOBER 12, 2007 PAGE: 1 OF 5
REVISION DATE:	(5-YEAR REVIEW FREQUENCY)

ISSUE:

All community water supplies and nontransient noncommunity water supplies must comply with the arsenic maximum contaminant level (MCL) of 0.010 milligrams per liter, or 10 parts per billion. In order to meet the arsenic MCL, many water systems will have to install treatment and most, if not all, arsenic treatment systems have to be periodically backwashed. Disposal options of the backwash water include pumping to an existing sanitary sewer line, surface water discharge, or groundwater discharge.

AUTHORITY:

R 325.10601 and R 325.10604c of the Administrative Rules adopted under the Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), being MCL 325.1001 *et seq.,* covering drinking water standards for specific contaminants, including arsenic and other inorganics, that shall be met by a supplier of water to assure the protection of public health. In addition, Section 325.1004 (2) of Act 399 states, "Upon receipt of the plans and specifications for a proposed waterworks system, the department shall evaluate the adequacy of the proposed system to protect the public health by supplying water meeting the state drinking water standards."

The Part 21, Part 22 and Part 23 Rules of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

DEFINITIONS:

Community Water Supply (CWS) – A public water supply that provides year-round service to not fewer than 15 living units, or that regularly provides year-round service to not fewer than 25 residents. Examples include municipalities, such as cities, villages, and townships; apartment complexes; manufactured housing communities; condominiums; and nursing homes.

Nontransient Noncommunity Water Supply (NTNCWS) – A noncommunity supply that serves not fewer than 25 of the same individuals on an average daily basis more than six months of the year. Examples include places of employment, schools, and day care centers.

POLICY:

CWS and NTNCWS have several treatment options to remove arsenic from drinking water, including conventional iron removal, modified iron removal, anion exchange and adsorptive medias. Each of these treatment processes will produce an arsenic residual. The amount of residual produced and the concentration of arsenic in the residual will depend upon a variety of factors, including raw water quality, type of treatment, frequency of backwashing or regeneration, and chemicals used in the treatment process.

This policy provides a description for Water Bureau staff of how to evaluate discharge options for backwash water. Those options include discharge to a municipal sewer, a National Pollutant Discharge Elimination System (NPDES) surface water discharge permit or a groundwater discharge permit.

Summary of Arsenic Removal Technologies

Conventional and modified iron removal processes - oxidation and filtration are used to remove both iron and arsenic from the water. Oxidation (aeration, chlorine, potassium permanganate) converts iron in the raw water to iron hydroxides. If arsenic is present, the oxidized form, arsenate [As(V)], is adsorbed onto the iron hydroxide precipitates and removed by filtration. The filters are periodically backwashed to remove the iron/arsenic particulates. If arsenic is in the raw water source, the backwash water usually contains arsenic concentrations above background levels.

Adsorption medias - remove arsenic by passing water under pressure through filter beds packed with the media and the As(V) in the raw water is adsorbed onto the media. When all the adsorption sites have been used up or exhausted, the media can be either regenerated or replaced. If any iron/arsenate precipitates are formed, arsenic will be removed by filtration, not adsorption. Since most groundwaters in Michigan contain some levels of iron, many adsorption filters will remove arsenic by both filtration and adsorption. These medias are usually backwashed every three-five weeks, not to remove the arsenic that has been adsorbed, but to uncompact the media and to remove any suspended solids that may have accumulated within the filter. The arsenic concentrations in the backwash water are usually at or below background levels, but can be higher if iron/arsenate particulates are present.

Ion exchange - is a physical-chemical process in which ions are exchanged between a solution phase and a solid resin phase. As(V) is removed through the use of anion exchange resin. Once the resin has been used to exhaustion, it can be regenerated on-site with brine. Single pass regeneration usually produces 40–50 bed volumes of brine waste. Due to the large volumes of regenerate water and concerns with high chloride and sodium concentrations in the waste stream, discharges to the groundwater from ion-exchange units are not eligible for a groundwater discharge permit exemption.

Arsenic Backwash Disposal Options

Connection to an existing sanitary sewer that flows to a wastewater treatment facility

The primary choice for discharge of water treatment backwash should be into a sanitary sewer system. Discharge to the sanitary sewer should be approved by the local wastewater treatment system owner prior to connection. If the system can handle the arsenic loading and not cause the wastewater treatment facility to violate its NPDES or state permit, no further assessment is necessary. The sanitary sewer must be evaluated to determine if it is able to accept the full flow of the disposal stream. If there is a mass loading concern, it may be necessary to install holding facilities to "bleed" the residual into the system. This may be accomplished by installing a tank or basin to hold at least a full backwash volume and then bleed in at a rate the sewer and waste facility can handle. The waste facility will be handling the same total arsenic loading over a long period as it receives now without any drinking water treatment. It is a mass balance issue that must be addressed through the Industrial Pretreatment Program (IPP), if applicable. Changes to the IPP may take several months to complete. The project construction and IPP changes can be done simultaneously. The water plant will be expected to comply with local requirements when the discharge commences.

Discharge to a surface water
If a sanitary sewer is not available for discharge of the backwash water, the second preferred method for discharge is to a surface water body, which will require an NPDES permit. A general NPDES permit, wastewater discharge from potable water supply will usually provide coverage for this type of discharge. NPDES permits have limitations and requirements, which will be stated on the permit. Information on how to apply for an NPDES permit can be obtained at the DEQ website, http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10440--,00.html.

Discharge to Groundwater
If neither a sanitary sewer nor surface water body is available for discharge, a groundwater discharge should be considered the method of last resort. R 323.2210 of the Part 22 Rules describes what discharges are allowed without obtaining an individual or general permit. Rule 2210(o) states that the discharge of water treatment filter backwash water is exempt from a groundwater discharge permit if disposal is in accordance with plans and specifications approved by the department under Act 399.

Criteria to qualify for Groundwater Discharge Permit Exemption
Backwash water from iron removal plants has historically been granted an exemption pursuant to R 323.2210(o). If arsenic is in the backwash water from an iron removal or adsorption processes, it will be in the form of iron/arsenate precipitates. The iron/arsenate bond is very strong and unless a reducing condition occurs, the arsenic will remain bonded to the iron and should not infiltrate back into the groundwater.

Since arsenic treatment units will be permitted under Act 399, backwash water from these units may qualify for an exemption. To be eligible for an exemption, the WB staff must approve, pursuant to Act 399, documentation provided by the applicant that one of the following conditions will be met:

1. The effluent will meet 201 residential clean up standards (10 ppb for arsenic) or background arsenic levels in the receiving groundwater, not the source groundwater, whichever is greater.

2. The seepage bed or infiltration area will remain aerobic due to permeable soils and sufficient surface area, thus precluding infiltration of arsenic into groundwater.

Monitoring well(s) may be required to be installed if it is determined by DEQ that arsenic could potentially be leaching into the groundwater.

In order to reduce the amount of arsenic going to a seepage bed, an intermediate holding tank can be installed. This will allow the iron/arsenate precipitates to settle in the tank and the decant water can be forwarded to the seepage bed. This arrangement will decrease the amount of arsenic being discharged to the seepage bed, but will require the holding tank to be pumped out by a licensed industrial waste hauler and the settled material to be properly disposed.

If a Water Bureau (WB) staff evaluation pursuant to Act 399 determines that neither Item No. 1 nor No. 2 can be met, a Groundwater Discharge Permit will be required.

Discharge to on-site wastewater systems

Discharges of water filtration backwash may occur to subsurface septic tank, tile field systems. The volume, frequency and timing of the discharge, and hydraulic impact on the system should be assessed. The WB staff would also have to follow the same evaluation process as described above for the seepage bed option to determine if the discharger qualified for a Part 22 groundwater discharge permit exemption pursuant to R 323.2210(o) or needed an individual Part 22 permit for the backwash water discharged. In order to discharge to a subsurface system, the discharger must install a holding tank dedicated exclusively to filter backwash water.

The Part 22 Rules [R 323.2210(a)] exempt discharges of sanitary sewage that is not mixed with other waste through septic tank/tile field systems, at volumes less than 6,000 gallons per day (gpd). Water filtration backwash water does not meet the Part 22 definition of sanitary wastewater. Mixing the two waste streams in a single septic tank would eliminate the exemption pursuant to R 323.2210(o) for the sanitary wastewater, and a Part 22 permit would be required if the two waste streams are mixed. However, the WB will allow the discharge of the two waste types from separate tanks to the same tile field if the following conditions are met:

1. The discharger must provide documentation that they have notified the local health department that has jurisdiction for approving their subsurface wastewater disposal system according to the "Michigan Criteria for Subsurface Sewage Disposal."
2. The discharge from the backwash holding tank shall not compromise the capacity of the tile field.
3. Discharge to the tile field from the backwash holding tank should be during off hours, when the likelihood of a sanitary discharge to the tile field is minimal.
4. The total discharge to the shared drain field cannot exceed 6,000 gpd.

REFERENCES:

Michigan Safe Drinking Water Act, 1976 PA 399, as amended, being MCL 325.1001 *et seq.*, and the administrative rules promulgated thereunder, being R 325.10101 *et seq.*

Part 22 Groundwater Quality Rules of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

United States Environmental Protection Agency (2003), *Arsenic Treatment Technology Evaluation Handbook for Small Systems,* EPA 816-R-03-014, July 2003.

REFERENCE TO BUREAU PROGRAMS:

This policy applies to the Public Water System Supervision and Groundwater Discharge Permit Program.

METHOD OF DISTRIBUTION:

The policy will be distributed via e-mail to staff assigned to the community water supply and groundwater discharge programs and located with the other WB policies on the WB common drive.

PROCEDURE:

Responsibility		**Action**
District Staff	1.	Incorporates this policy as part of the permit process to construct arsenic treatment systems including the disposal of backwash water from arsenic removal units.
District Staff	2.	Review arsenic backwash water discharge proposals and determine if the method of disposal meets the specific criteria for that method listed within the policy.
District Staff	3.	Inform the district supervisor of any discharges that require either a groundwater or surface water permit.
District Supervisors and Assistant District Supervisors	4.	Assist district staff in all matters pertaining to the disposal of arsenic backwash waters. Contacts applicant in writing, with a copy to permit staff, that either a groundwater or surface water permit is required, and that they should contact the appropriate permit authority to begin the permit process.

APPROVED: Richard A. Powers DATE: 10/11/07
Richard A. Powers, Chief
Water Bureau

LAST REVIEWED BY: ______________________ DATE: ______________
Name
Title

This policy provides guidance to staff regarding the implementation and interpretation of laws administered by the DEQ. It is merely explanatory, does not affect the rights of or procedures and practices available to the public, and it does not have the force and effect of law.

WATER BUREAU
POLICY AND PROCEDURES

NUMBER:	**WB-013**	
SUBJECT:	**CLASSIFICATION OF PUBLIC WATER SUPPLIES**	
EFFECTIVE DATE:	**OCTOBER 12, 2007**	**PAGE: 1 OF 6**
REVISION DATE:	(5-YEAR REVIEW FREQUENCY)	

ISSUE:

A classification system for public water supplies is established under the Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), being MCL 325.1001 et seq. and the administrative rules promulgated thereunder, being R 325.10101 et. seq. Public water systems are classified by the population served or the nature of their customer base. For instance, Type I (Community) systems are categorized by the number of living units served or the number of people served on a year-round residential basis. Type II (Noncommunity) systems are categorized by the population served as well as by the number of days service is provided.

The reference manual titled, "Suggested Practices for Water Works," that was developed for state and local regulatory staff to implement the requirements of Act 399, contains a section that established a reasonable approach to estimating population. However, changing trends in development have made the calculation of the number of year-round residents difficult. Therefore, updated guidance is necessary. Some issues need clarification so that consistent criteria can be applied and classification will be uniform across the state. This policy is to identify these issues and establish the method or approach the Water Bureau (WB) will use for water systems that may have unusual or unique service characteristics.

AUTHORITY:

Regulatory authority over public water systems is performed by the WB, with Part 5 of the administrative rules of Act 399 establishing the classification of public water systems. The WB provides direct oversight for Type I systems and delegates the authority over Type II water systems to local health departments under Section 16 of Act 399. Type III public water systems may also be regulated by local health departments if they elect to do so. Type III water system requirements are limited to complying with the well construction code and applicable state and local plumbing codes.

DEFINITIONS:

Employee: For purposes of classification as nontransient noncommunity public water systems, a person shall be counted as an employee if they are present an average of four hours per day for four days per week. Employees not meeting these criteria shall be counted as transient customers.

Full Capacity: For the purposes of classification, full capacity is the number of permanent beds available for the people housed in a facility, such as students in a dormitory, prisoners in a penal institution, residents in a nursing home or foster care home, patients in a mental institution, etc. This number does not include cots, daybeds, or roll-away beds that may be used in times of overcrowding or for short-term visitors who are staying overnight with a resident.

Categorized based on the number of permanent beds: For the purpose of classification, "categorized based on the number of beds" is the respective industry standard of measurement for the size of a facility, such as the number of prisoners a prison facility can house, the number of patients for which a nursing home can care, or the number of students a dormitory may house.

Living Unit: Living unit means a house, apartment, or other domicile occupied or intended to be occupied on a day-to-day basis by an individual, family group, or equivalent.

Year-Round Service: Year-round service means the ability of a supplier of water to provide drinking water on a continuous basis to a living unit or facility.

A breakdown of the classification of public water systems is summarized in the table below.

Types of Public Water Systems

<table>
<tr><th colspan="3">Classification</th><th>Description</th><th>Examples</th></tr>
<tr><td rowspan="4">Public Water System</td><td colspan="2">Type I
Community</td><td>Provides year-round service
to ≥15 living units
OR to ≥25 residents</td><td>Municipalities, subdivisions, apartments, condominiums, nursing homes, manufactured housing communities</td></tr>
<tr><td rowspan="2">Type II *
Noncommunity</td><td>Nontransient</td><td>Serves ≥25 of the SAME individuals
on an average daily basis
for ≥6 months/yr (and is not a Type I)</td><td>Places of employment, schools, day care centers, bottled water sources</td></tr>
<tr><td>Transient</td><td>Serves ≥25 individuals or ≥15 service connections on an average daily basis for ≥60 days/yr (and is not a Type I)</td><td>Hotels, restaurants, campgrounds, churches, highway rest stops</td></tr>
<tr><td colspan="2">Type III</td><td>Public water system that is
not a Type I or Type II</td><td>Subdivisions, apartments, condominiums, or duplexes with 2-14 living units, facilities serving <25 individuals or open <60 days per year</td></tr>
<tr><td colspan="3">Private Water System</td><td>Serves a single living unit</td><td>Single family home</td></tr>
</table>

* Type II public water systems are also classified according to their average water production during the month of maximum water use. A Type IIa system produces 20,000 or more gallons per day and a Type IIb system produces less than 20,000 gallons per day.

Type I Public Water System: A Type I public water system provides year-round service to not fewer than 15 living units or regularly provides year-round service to not fewer than 25 residents. A resident is an individual who owns or occupies a living unit. Type I public water systems are also called community supplies.

Type II Public Water System: A Type II public water system provides service on an average daily basis to 25 or more individuals or 15 or more service connections for not less than 60 days per year, but does not meet Type I criteria. Type II public water systems are called noncommunity supplies.

Type III Public Water System: Type III public water systems are all other water systems that serve more than a single family residence but are not Type I or Type II supplies.

POLICY:

Classifying a public water system as Type I: Public water systems that provide year-round service to 15 or more living units inhabited by the same individuals shall be classified as Type I public water systems regardless of the number of individuals present. Facilities that are licensed, regulated, rented, leased, sold, or otherwise categorized based on the number of beds at full capacity shall be classified as Type I public water systems if their full capacity is 25 or more beds, regardless of the number of beds occupied on any given day. These facilities include, but are not limited to: nursing homes, homes for the aged or indigent, adult foster care homes, dormitories, penal institutions, and mental institutions, if they provide year-round service.

Classifying a public water system as Type II: Public water systems that are not Type I public water systems but serve 25 or more people or 15 or more service connections for at least 60 days per year shall be classified as Type II public water systems. These facilities include, but are not limited to: schools, day care centers, campgrounds, restaurants, seasonal resorts, hotels, and churches.

Classifying a public water system as Type III: Public water systems that are not Type I or Type II public water systems are classified as Type III. These facilities include, but are not limited to: duplexes, apartments or condominiums serving 2-14 living units, and facilities serving less than 25 individuals or open less than 60 days, and adult foster care homes with fewer than 25 residents and employees.

Bottled Water Sources: Sources for bottling water facilities that are not community supplies are classified as Type II public water systems and shall be considered nontransient.

Condominiums: Condominium developments subdivided into living units are classified by the number of living units having year-round service that are incorporated under a single legal entity. Unless an acceptable legal mechanism restricts owner occupancy to less than 6 months per year, a condominium development consisting of 15 or more living units having year-round service will be classified as a Type I public water system. If less than 15 living units are present, the development is classified as a Type III system unless there are more than 25 individuals present on 60 or more days, in which case it will be classified as a Type II public water system.

If the condominium development is subdivided into something other than living units, such as commercial units, the water system will be classified by the total number of employees/people expected to be present throughout the development on an average daily basis at least 60 days per year. If that number is 25 or more, the system will be classified as a Type II water supply. If it is

25 or more employees, the system will be classified as a nontransient noncommunity water supply. If it is less than 25 employees/people, it will be considered a Type III water supply.

Condominium hotels: Condominium hotels or other facilities that provide housing for more than 25 guests or serve fluctuating populations, such as seasonal housing, resorts, time-share condominiums, extended stay hotels, and short-term apartments, will be classified as Type II public water systems if they legally restrict the length of stay for owners of the individual units to less than 6 months per year. The limitation shall be in a mechanism that discloses to anyone intending to purchase, lease, rent, sublet, or otherwise enter into an agreement for the purpose of residing in the domicile, even if the intent is to reside for a time less than six months. The purpose is to ensure that prospective purchasers or renters fully understand that the domicile may not be sold or rented for occupancy on a continuous basis or for a period greater than six months per year. Appropriate mechanisms legally restricting the length of stay and disclosing the limitation to prospective *buyers* may include, but are not limited to, deed restrictions, association constitutions, and disclosure documents that are also used to disclose contamination on the property or structural problems or other concerns normally required by common real estate law to disclose. Examples of mechanisms that do not provide sufficient restrictions on the length of stay and disclosure for prospective *buyers* are association bylaws, contracts to rent, lease, or purchase the domicile or time-share to occupy the domicile.

Condominium hotels or other facilities that continuously supply 15 or more living units without providing acceptable legal restrictions on the length a resident may occupy a unit will be classified as Type I public water systems.

Seasonal vs. year-round: Vacant or unoccupied living units will be counted in the number of year-round living units for determining classification of the water system if water service is maintained for possible, intermittent, or immediate occupancy. Living units that have their service shut off and service line drained for winter months will not be counted.

Changing the classification of a public water system: Changes in classification should be avoided. Every attempt should be made during initial contact with developers to determine the residential nature of a facility and an ultimate build-out capacity. In doing so, the initial water system construction can be made to accommodate future changes in system capacity and reclassification when future phases are constructed. Requirements for well isolation and construction, along with ownership and oversight, are just a few items that vary significantly based on classification and for which it will be difficult to achieve compliance after initial water system installation.

If condominium hotels, resorts, time-share condominiums, etc, later decide to convert $\geq$15 living units to allow for year-round occupancy, then the public water system shall meet Type I construction standards. If the system does not meet Type I construction standards at the time it becomes a Type I public water system, then the WB shall consider the public water system a "new" system for the purpose of capacity development and shall ensure the public water system has technical, financial, and managerial capacity to operate as a Type I community water system, including the possibility of having to install wells that comply with Type I construction and isolation standards.

The WB will not reclassify public water systems from one year to the next based on the current occupancy or vacancy rates. A Type I system serving 15 or more living units whose population becomes less than 25 people will not be reclassified as a Type III system. However, if we are notified that a Type III system serving 2-14 living units is serving a population of 25 or more, WB staff will confirm the population and reclassify the system as a Type I water system if they confirm a year-round residential population of 25 or more. Reclassification of systems providing service to a changing number of living units will only occur if the facility provides documentation to that effect.

Reclassification of facilities categorized based on the number of permanent beds will only occur if the number of beds has changed.

Any reclassification of a public water system shall be made in writing to the owner, with copies of this notice provided to the appropriate regulatory agency if the oversight responsibility is also changing.

Contiguous property: According to Rule R327.10503 two or more waterworks systems owned or operated by the same person at the same general location, not individually meeting the definition of a community supply or a noncommunity supply, but collectively meeting the definition of a community supply or noncommunity supply, shall be considered by the WB to be a single public water supply for classification purposes.

REFERENCES:

Michigan Safe Drinking Water Act, 1976 PA 399, as amended

REFERENCE TO BUREAU PROGRAMS: Programs impacted by the policy are in the list below.

Bureau programs:

Public Water System Supervision	Groundwater Management Program
Campground Permit and Inspection Program	Security Program

METHOD OF DISTRIBUTION:

The policy will be distributed by e-mail and available on the common drive. It will be included in the training manuals for new drinking water program staff. It will be distributed to local health departments by e-mail and included in the Reference Manual for county sanitarians. If possible, it will also be placed on the WB Web site.

PROCEDURE:

Responsibility		Action
WB district staff, or the local health department (LHD) personnel for the Noncommunity Program	1.	Establishes the classification of the public water system based on documentation provided by the owner/developer. Notifies owner/developer of responsibilities should subsequent change in population or service characteristics result in a change of classification. Monitors supply for changes that may affect classification. Makes timely entry into SDWIS.
Public water supply	2.	Provides WB or LHD with documentation of a change in the population served, the number of living units served, the full capacity of the facility, or the occupancy restrictions for living units served by the public water system.
WB district staff for Community Program, or the LHD personnel for the Noncommunity Program	3.	Determines if documentation is sufficient to change the classification of an existing public water system. Consults with other regulatory agency if a change in classification is warranted. Documents the change in classification in writing and notifies appropriate regulatory agency if oversight responsibility changes.
Supplier of a public water system serving or intending to serve residents for less than 60 days or 6 months per year.	4.	Provides appropriate documentation legally restricting residents from staying in the living unit for more than 60 days or more than 6 months per year and sufficiently discloses the restriction to prospective purchasers or renters.
WB district staff, or the LHD personnel for the Noncommunity Program	5.	Determines if the documentation legally restricts residents from staying in the living unit for more than 60 days or more than 6 months per year and sufficiently discloses the restriction to prospective purchasers or renters.

APPROVED: Richard A. Powers DATE: 10/11/07
Richard A. Powers, Chief
Water Bureau

LAST REVIEWED BY: ______________________ DATE: ____________
Name
Title

This policy provides guidance to staff regarding the implementation and interpretation of laws administered by the DEQ. It is merely explanatory, does not affect the rights of or procedures and practices available to the public, and it does not have the force and effect of law.

WATER BUREAU
POLICY AND PROCEDURES

NUMBER:	**WB-014**	
SUBJECT:	**GUIDELINES FOR ISSUING BOIL WATER ADVISORIES TO ADDRESS POTENTIAL MICROBIAL CONTAMINATION OF COMMUNITY WATER SUPPLIES**	
EFFECTIVE DATE:	**OCTOBER 12, 2007**	**PAGE: 1 OF 9**
REVISION DATE:	(5-YEAR REVIEW FREQUENCY)	

ISSUE:

Community water systems are expected to provide customers with a continuous supply of water that meets both federal and state drinking water standards. However, there may be circumstances when the public must be notified that the water may not be safe. In these circumstances, a boil water advisory may be issued to prevent illness from known or suspected microbiological contamination. This policy is to provide guidance to Water Bureau (WB) drinking water program staff on advising community water system personnel when to issue and rescind a boil water advisory, the appropriate content, and the manner and method of delivery.

AUTHORITY:

Administrative rule R 325.10401a promulgated under the Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), being MCL 325.1001 *et seq.,* requires public notification for violations of maximum contaminant levels and treatment techniques plus other situations as determined by the department. Each public notice is required to state what actions consumers should take during a violation, which may include a statement recommending water customers boil all water used for consumption until further notice.

In addition, R 325.11207 allows the Department of Environmental Quality (DEQ) to require the supplier of water to provide notice to customers or users that include any precautionary measures deemed necessary when an interruption in water service occurs, which could include low, zero or negative pressure events.

Furthermore, R 325.12303 requires a supplier of water to include in their contingency planning a description of precautions or measures to be taken to protect the health of those customers or users that may be affected by an emergency. R 325.12304 also requires a supplier of water to notify the DEQ when an emergency is discovered and how the supply will notify its customers or users. While the content of this notification to customers or users may vary depending upon individual circumstances, each notification to customers or users must state what actions or precautions they should take, which may include a statement to boil all water used for consumption until further notice.

DEFINITIONS:

Boil Water Advisory (BWA) – A written or verbal advisory issued by the community water system or DEQ notifying the users of the water system that the water is or may be contaminated and advising them to boil the water prior to using it for drinking or cooking.

Community Water Supply (CWS) – A public water supply (PWS) that provides year-round service to not fewer than 15 living units, or that regularly provides year-round service to not fewer than 25 residents. Examples include municipalities, such as cities, villages, and townships; apartment complexes; manufactured housing communities; condominiums; and nursing homes.

Complete Loss of Pressure – Sustained negative pressures or pressure below five psi in any portion of a distribution system. It does not include instantaneous low or negative pressure occurring from pressure surges caused by pump cycling, valve operation, or other water hammer events.

Maximum Contaminant Level (MCL) – The maximum permissible level of a contaminant in water that is delivered to any user of a PWS.

Repeat Sample – a sample that is collected and analyzed in response to a previous coliform-positive sample.

Routine Sample – a water sample that is collected and analyzed to meet the monitoring requirements for total coliform, as outlined in the written sampling plan.

Tier 1 Public Notice – A public notice required to be provided as soon as practical but not later than 24 hours after the supplier learns of a violation or situation that has significant potential to have serious adverse effects on human health as a result of short-term exposure. A Tier 1 Public Notice also requires the supplier to initiate consultation with the DEQ as soon as practical but not later than 24 hours after the supplier learns of the violation or situation. Examples of these violations or situations include:

1) A violation of the Total Coliform MCL when fecal or *E.coli* are present in the distribution system;
2) A violation of the treatment technique requirement resulting from a single exceedance of the maximum allowable turbidity limit;
3) An occurrence of a waterborne disease outbreak;
4) A failure or significant interruption in key water treatment processes;
5) A disruption of the water supply or distribution system; and
6) Other violations or situations as determined by the DEQ on a case-by-case basis.

A violation or situation that requires a Tier 1 Public Notice also requires the supplier to consult with the department to determine additional public notice requirements, including the timing, form, manner, frequency and content of the notice designed to reach all persons served, and any repeat notices or directions. At a minimum, one or more of the following forms of delivery must be used:

1) Appropriate broadcast media:
2) Posting of the notice in conspicuous locations throughout the area served by the system;
3) Hand delivery of the notice to persons served by the system; or
4) Another delivery method approved by the DEQ.

Within 10 days of completing the Tier 1 Public Notice, the supplier shall submit to the DEQ a certification that it fully complied with the public notification requirements, including a representative copy of the type of notice distributed to persons served by the system and to the media.

Tier 2 Public Notice – A public notice required to be provided as soon as practical but not later than 30 days after the supplier learns of a violation or situation that has the potential to have serious adverse effects on human health. Examples of these violations or situations include:

1) All violations of MCL, maximum residual disinfectant level, and treatment technique requirements except where the DEQ determines a Tier 1 notice is required.
2) Violations of monitoring and testing procedure requirements, taking into account potential health impacts and persistence of the violation; and
3) Failure to comply with a variance or exemption.

For a Tier 2 Public Notice, the DEQ may, on a case-by-case basis, grant extensions in writing for up to three months from the date the supplier learns of the violation or situation, for reasons such as coordinating with billing cycles or if the violation or situation was quickly resolved and no longer poses any risk to the persons served. A Tier 2 Public Notice shall be repeated every three months as long as the violation or situation exists. A Tier 2 Public Notice and any repeat notices shall be in a form and issued in a manner that is reasonably calculated to reach persons served in the required time period. At a minimum, the notice shall be provided:

1) By mail or direct delivery to each customer receiving a bill and to other service connections to which water is delivered by the supplier, and

2) By other methods reasonably calculated to reach other persons not receiving a bill, such as apartment dwellers, university students, nursing home patients and prison inmates. Other methods may include:

(a) Publication in a local newspaper
(b) Delivery of multiple copies to apartment complexes and manufactured housing communities
(c) Posting in public places or on the internet
(d) Delivery to community organizations

Treatment Technique (TT) – Minimum treatment requirement or a necessary methodology or technology that is employed by a supplier of water for the control of the chemical, physical, biological, or radiological characteristics of a PWS.

POLICY:

A BWA may be issued for a variety of reasons when microbial contamination is known or suspected. Total Coliform Rule (TCR) MCL violations, surface water TT violations, low or loss of pressure events, and waterborne disease outbreaks are circumstances when a BWA may be issued. Each of these situations is discussed in detail below. However, these situations are not the only times a BWA can or should be issued. Each incident must be handled on a case-by-case basis, using professional judgment to evaluate the circumstances in each situation.

Finally, there may be situations when water systems experience contamination that is not microbial, but chemical due to a chemical spill or backflow due to a cross connection. In these cases, a notice to customers could include "Do Not Use" language since boiling the water may not remove the contamination.

Types of Incidents

A. Violation of a Drinking Water Standard

1. TCR MCL Violations

An acute TCR MCL violation occurs when monitoring indicates the presence of coliform organisms in both a routine and a follow-up repeat sample in the same monitoring period, and either analysis (routine or repeat) is also positive for fecal or *E.coli.* Because this MCL violation confirms the presence of a more direct connection to contamination, these violations warrant issuance of a BWA, unless there are unique circumstances.

A nonacute TCR MCL violation occurs when monitoring indicates the presence of coliform bacteria in 2 or more samples in the same monitoring period for a supplier collecting less than 40 samples per month, or in more than 5 percent of the samples for a supplier collecting 40 or more samples per month, and the criteria for an acute violation did not occur, i.e., fecal coliform or *E.coli* were NOT detected present in either a routine or repeat sample. For example, a system that collects 5 samples per week for a total of 20 per month may have 1 sample report positive for total coliform or fecal/*E.coli* during the first week, but all repeat samples report negative for coliform. If another sample in a subsequent week also reports total or fecal/E.coli positive, but again, all repeat samples are coliform-negative, then a nonacute TCR MCL violation has occurred because 2 or more samples reported positive for coliform, but no fecal coliform or *E.coli* were detected in both a routine and a repeat sample.

When a nonacute violation occurs, staff should evaluate possible sources of contamination. If a source is identified that is considered likely to contribute disease causing organisms or result in water of questionable quality still being distributed, a BWA should be instituted. Examples of contaminant sources that would elevate the public health risk include, but are not limited to:

- flooding of the wells
- failure of the treatment system
- recent construction activity in the distribution system
- vermin (birds, rodents, etc.) activity in storage tanks
- system-wide or extensive pressure loss in the distribution system

Even if the source of contamination is not easily identified, a BWA may be appropriate for a nonacute TCR violation if the violation is widespread or ongoing. A BWA shall be instituted if monitoring indicates *E. coli* or fecal coliform contamination unless unusual circumstances warrant consideration, such as the absence of any coliform in repeat samples, or when staff are assured that the contamination has been eliminated before confirmation results are available.

However, not every TCR MCL violation must result in a BWA. There may be a few exceptions when there is a TCR MCL violation but a BWA is not needed. For example, a violation may be declared in situations where samples collected on different days from widely dispersed locations report coliform present even though repeat samples do not show positive results. In this case, the sampling results may constitute a MCL violation, but a BWA may not be necessary.

If a BWA is deemed necessary by the WB, it should be issued as soon as possible but no later than 24 hours after the system learns of the violation. Because violation of an MCL results in required public notification (PN) per the PN Rule, the water supply may issue the PN and BWA simultaneously in one document (highly recommended) and must meet all the requirements of a Tier 1 PN and include BWA language.

After measures have been taken to eliminate the source(s) of contamination, such as initiating or increasing chlorine feed rates and system flushing, additional sampling must be conducted. Raw water bacteriological sampling is also encouraged to eliminate the raw water as the possible source of contamination. For MCL violations, the BWA can be rescinded after the analyses of two sets of samples collected 24 hours apart report the absence of coliform bacteria. The number of samples in each set should be a minimum of five samples, but can be decreased or increased based on system size or the extent of the affected area. Systems are encouraged to use routine sample sites if available, and to use extra care if routine sites are not available.

2. Surface Water Treatment Rule (SWTR) TT Violations

SWTR TT violations include:

- exceedance of turbidity standards at filter confluence point
- failure to meet disinfection contact time requirements (C*T)
- failure to meet disinfection residual standards

Upon determination of a SWTR TT violation, WB staff must determine if the violation poses a threat to public health. For example, if the turbidity levels at the filter confluence point were found to have exceeded 0.3 nephlometric turbidity units (NTUs) in 95 percent of the samples in a two month period, a SWTR TT violation has occurred. Based upon a review of plant performance and consultation with program managers, staff may determine that no significant health risk was posed and no BWA is necessary. However, the water supply must still issue a Tier 2 PN within 30 days of the violation. On the other hand, a BWA is likely to be necessary for a treatment plant that gets overwhelmed by excessive runoff and reports a turbidity level in excess of 1.0 NTU at the filter confluence point for a four-hour period.

If the TT violation is on-going or prolonged, or the WB determines a significant public health risk is posed, WB staff may elevate the PN to Tier 1 status, which must be issued within 24 hours and include BWA language. After appropriate measures have been taken to reduce or eliminate any health risk, additional monitoring must be conducted. Appropriate measures may include increasing coagulant dose, increasing chlorine residuals through the treatment plant, backwashing filters more often and flushing key system components. In this case, a

BWA can be rescinded after analyses of two sets of samples collected 24 hours apart report the absence of coliform bacteria. The number of samples in each set should be a minimum of five samples, but can be decreased or increased based on type and severity of the TT violation.

Surface water plants utilizing conventional or direct filtration must add a primary coagulant under R 325.11008. Failure to add a primary coagulant is a violation of Act 399, and may also contribute to a TT violation under R325.10611 (Filtration and Disinfection) which requires 3-log inactivation of giardia and 4-log inactivation of viruses. In these cases, WB staff will have to determine if the violation poses a threat to public health and whether other actions are necessary, such as requiring a BWA. Factors to consider if a BWA is necessary would include chlorine residual concentrations throughout the treatment plant, raw water quality, C*T compliance, plus individual filter effluent and combined filter effluent turbidity levels.

B. Waterborne Disease Outbreaks

Waterborne disease outbreaks can be declared by the Centers for Disease Control, the Department of Community Health, a local health department, or other public health institutions. If an outbreak is declared, the WB will work with the declaring agency to ensure affected community public water supplies take appropriate measures to mitigate public exposure. These measures will include appropriate public notification, including instructions to boil water if appropriate. The WB will allow the water supply to rescind the notification when the agency declaring the outbreak indicates it is safe to do so as the result of additional monitoring.

C. Interruptions in Service

1. Negative or Complete Loss of Pressure

A complete loss of pressure or negative pressure in the distribution system must result in a BWA being issued to all water customers in the impacted area. After pressure is restored and the system recovers (tanks are filling and enough sources are operating to ensure pressures don't drop again), the affected area should be thoroughly flushed and coliform samples must be taken throughout the area to determine if the distribution system remains free of coliform contamination. The number of samples will vary depending on the size of the system and the extent of the area impacted. For very small systems that experience a power failure that results in a complete loss of pressure throughout the distribution system, a minimum of three samples should be collected. If applicable, chlorine residual measurements should be taken to ensure that an adequate disinfectant residual is present. If possible, chlorine dosages and residuals should be increased by 1 to 2 parts per million during this period as a corrective and preventive measure. If the first round of sampling does not detect coliform bacteria, the advisory may be rescinded. However, if the first round of sampling detects coliform bacteria, additional flushing should be conducted in the area where the positive coliform samples were collected and a second round of coliform samples collected from the area. The BWA should remain in effect until safe coliform sample results are obtained.

2. Low Pressure Events

Low pressure events may not result in a BWA as long as the pressure did not drop below 5 psi. Low pressure is considered a drop in pressure below 20 psi but greater than 5 psi. A drop in water pressure in a distribution system could allow contamination to enter the water system through backflow by backpressure or backsiphonage. The decision to issue a BWA should be made on a case-by-case basis and be based upon professional judgment of all available data that may indicate the extent of the problem, such as:

- Geographical extent of the pressure loss
- Nature of the service area (residential vs. commercial/industrial)
- Duration of the low pressure condition
- Disinfection practices of the water system
- Relative elevation differences in the service area
- Status of the local cross connection control program
- Age and condition of the underground piping
- Amount of underground piping located in areas of a high groundwater table
- Ability and willingness of the operators to rapidly apply chlorine to the system or distribute an increased chlorine residual throughout the affected area

After normal pressure is restored, the impacted area should be thoroughly flushed and coliform samples taken throughout the area to determine if the distribution system is free of any bacteriological contamination. The collection of coliform samples after low pressure events is not absolutely required, but may be recommended based on the factors above.

3. Water Main Breaks or Repairs

A BWA may be issued during water main breaks and after the break has been repaired. Whether or not to issue a BWA will depend on the location and severity of the break and, more importantly, a decision based on sound engineering judgment that the integrity of the water system has been maintained. If at all possible, repairs should be performed under reduced or low pressure by closing the closest valves on each side of the break just enough to reduce the flow so the repairs can be made under pressure while the water flowing from the break is diverted away from the excavation to maintain clean sanitary conditions. If the water main can be repaired under pressure, and no nonpotable water, soil, or other potential contaminants entered the main during the break and repair process, then a BWA is not necessary. If the water main that was removed from service is flushed, disinfected, and sampled in accordance with AWWA Standard C651 before being placed back into service, a BWA does not need to be issued.

If a water main break results in a complete loss of pressure before, during, or after the repair is made, a BWA must be issued to all customers in the affected area. The BWA should remain in effect until the area is flushed, chlorine residuals are reestablished (if applicable), and sample results do not detect coliform bacteria.

Content and Delivery of a BWA

If the WB determines a BWA is necessary, the water supply must issue the advisory as soon as practical, but not later than 24 hours after being advised to do so. The supply must make a good faith attempt to notify all customers in the affected area. Appropriate methods of distribution are situation specific, but may include radio or television broadcasts, hand delivery, and/or posting in conspicuous locations throughout the area. Delivery requirements as detailed in the PN Rule should be used to determine appropriate delivery methods.

Although there are content requirements for public notification under the PN Rule, there are no requirements specific to boil water language. To ensure all appropriate information is transmitted to the customers, a BWA should include the same content elements as required for public notification under the PN Rule. If a BWA is issued as the result of an MCL violation and the water supply issues the BWA in conjunction with the required PN (highly recommended), the content MUST meet all PN Rule content, delivery, and reporting requirements.

The WB boil water language is consistent with the Environmental Protection Agency policy that requires water be brought to a boil and allowed to boil for one minute before use. The language also suggests the use of bottled water as an alternative to boiling, and describes the circumstances under which boiled or bottled water should be used.

Staff should notify the appropriate local health department and the Food and Dairy Division of the Department of Agriculture whenever a BWA is issued or rescinded. These agencies may receive calls from concerned customers or be involved in oversight of facilities impacted by the boil advisory and, therefore, need to be aware of the situation.

Several BWA templates have been created and are available to WB staff on the WB common drive. To ensure consistency and inclusion of all necessary content, these templates should be used as the basis for PNs and/or a BWA. Available templates include, but are not limited to:

- Advisory for a TCR MCL.
- Advisory for a low/no pressure event.
- Notification for cancellation of a BWA.

REFERENCES:

Michigan Safe Drinking Water Act, 1976 PA 399, as amended, being MCL 325.1001 *et seq.*, and the administrative rules promulgated there under, being R 325.10101 *et seq.*

REFERENCE TO BUREAU PROGRAMS:

This policy applies to the Public Water System Supervision, CWS Program.

METHOD OF DISTRIBUTION:

The policy will be distributed via email to staff assigned to the community water supply program, entered into and retained in the PWS engineers' reference manual, and located with the other Water Bureau policies on the WB common drive.

Responsibility		**Action**
Public Water Supply	1.	Notify DEQ of results in a timely manner as required by law and follow through with appropriate actions.
District Staff	2.	Respond to all TCR and TT violations plus complete loss of pressure events in a timely manner and determine whether a BWA needs to be issued.
	2.	If needed, assist supply in drafting BWA and determining most appropriate method of delivery with approval from the District Supervisor or Assistant District Supervisor.
	3.	If a BWA is needed, assist the supply in determining actions to remove the possible contamination including steps needed to rescind the BWA.
	4.	Provide on-site technical assistance for acute TCR MCL violations and other boil water situations as appropriate.
District Supervisors	5.	Assist District Staff in the all matters pertaining to issuing a BWA.

APPROVED: Richard A. Powers (signature) DATE: 10/11/07
Richard A. Powers, Chief
Water Bureau

LAST REVIEWED BY: ______________________ DATE: __________
Name
Title

This policy provides guidance to staff regarding the implementation and interpretation of laws administered by the DEQ. It is merely explanatory, does not affect the rights of or procedures and practices available to the public, and it does not have the force and effect of law.

Appendix B

Miscellaneous Documents

Recommended Practices For Treatment Optimization

Determining Peak Demands For Small Water Supplies

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STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF PUBLIC HEALTH

3423 N. MARTIN L. KING JR. BLVD.
P.O. BOX 30195, LANSING, MICHIGAN 48909
VERNICE DAVIS ANTHONY, MPH, Director

May 23, 1995

TO: Michigan Surface Water Treatment Plant Operators

Subject: Water Treatment Optimization Practices

Gentlemen/Ladies:

Several weeks ago U.S. EPA administrator Carol Browner outlined in a press conference a voluntary plan aimed at improving the overall effectiveness of surface water treatment facilities. The plan, called "The Partnership for Safe Water," is designed to encourage drinking water utilities to survey their facilities, treatment processes, operating and maintenance procedures, and management oversight practices to identify areas that will enhance the system's ability to prevent the entry of *Cryptosporidium, Giardia,* and other microbial contaminants to treated water. National partners include EPA, the Association of State Drinking Water Administrators, AWWA, the AWWA Research Foundation, the Association of Metropolitan Water Agencies, and the National Association of Water Companies.

In response to the outbreak of *Cryptosporidiosis* in Milwaukee, the Division of Water Supply has set forth practices for water utility officials to follow which should minimize the potential for such an event in Michigan. The attached recommended practices is the product of an ad hoc committee of Michigan water plant superintendents and others knowledgeable of complete water treatment operations. This document parallels in a somewhat condensed manner the goals of the EPA's national partnership plan which some Michigan communities have voluntarily agreed to participate in.

We urge that every surface water treatment plant superintendent and their staff critically examine their respective water treatment operations using the enclosed material as guidance. Should there be any questions about the recommended practices, please contact your district engineer.

Very truly yours,

James K. Cleland

James K. Cleland, P.E., Chief
Division of Water Supply
Bureau of Environmental and
Occupational Health

JKC:MKM
Enclosure

Z-25 5/94

May 16, 1995

SUBJECT: Recommended Practices for Treatment Optimization

OVERVIEW

Increasing awareness of the potentially severe impact of cryptosporidium in drinking water has refocused attention on the importance of optimal water treatment. Because cryptosporidium is resistant to the disinfectants typically used in water treatment plants, it is essential that every effort be made to effect their removal through the pretreatment and filtration processes.

The department has utilized the input of a group of Michigan water treatment plant superintendents to develop recommended practices in four areas: treatment goals, monitoring protocols, treatment optimization, and emergency operating procedures. These treatment practices must be optimized if Michigan water supplies are to continue to avoid the cryptosporidiosis outbreaks experienced in other areas of the country.

TREATMENT GOALS

The goal of all water treatment plants should be to consistently produce finished water turbidities of 0.1 ntu or less.

The goal for each individual filter should be to consistently produce water with turbidities of 0.1 ntu or less.

The goal of plant operators should be to minimize the size and duration of turbidity increases above 0.1 ntu in individual filters after the following:

1) Restarting filters after backwash.
2) Restarting unwashed filters after routine plant shutdown.
3) Changes in filtration rates.
4) Changes in settled water quality.

MONITORING PROTOCOLS

Conformance with the treatment goals outlined above can only be determined if the necessary monitoring information is available. It is recommended that continuously recording turbidimeters be provided for:

1) Raw water.
2) Settled water.
3) Each individual filter.
4) Combined filter effluent.

Where it is not feasible to provide a turbidimeter for each filter, it is recommended that each group or bank of filters be provided with one turbidimeter and the necessary piping and valving to allow for monitoring of a specific filter or the entire group of filters.

It is recommended that particle counters be utilized to determine the effectiveness of optimized treatment. Particle counters have the potential to provide an earlier and more sensitive detection of water quality changes than turbidimeters. It is recommended that settled water and filtered water particle counts be monitored as another indicator of treatment efficiency and to provide a numerical measure of the removal of particles in the 2-5 micron cryptosporidium size range.

Because of the high cost and uncertain reliability of cryptosporidium and giardia testing, the State does not recommend routine testing for these parameters at this time. However, if improvements in methods and reductions in analytical costs occur, this type of monitoring will become useful in evaluating plant performance. Cryptosporidium and giardia testing is currently optional for water utilities and may be useful depending on specific conditions. Such testing may be required in the future by U.S. EPA regulation. The limitations of current laboratory methods can lead to uncertain or unreliable results. As such, utilities which pursue testing must carefully interpret these results. Careful selection of qualified laboratories is also an important factor when considering such testing.

TREATMENT OPTIMIZATION

There is an extensive amount of literature published on the subject of water treatment. A list of selected references pertaining to treatment optimization is attached. Based on a series of meetings with water treatment plant superintendents, a number of treatment practices were identified as being potentially important with regard to cryptosporidium removal, and in achieving the treatment goals listed above.

For coagulant feed control, the following practices should be examined:

1) Routine jar testing.
2) Use of streaming current detectors or other methods for controlling coagulant feed rates.
3) Optimization of the rapid mix and flocculation stages of treatment, including periods when backwash water is recycled.
4) Use of polymers.

The effectiveness of previous coagulant adjustments made in response to adverse changes in raw water quality caused by climatic and hydrologic events should be reviewed.

For filter operation, the following practices should be examined:

1) Filtering to waste following backwash.
2) Adding coagulant directly onto the filter influent following backwash, in the backwash water, or at the end of a backwash.
3) Allowing filters to set for a period of time following backwash before returning to service.
4) Ramping up the flow rate onto any filter being returned to service.
5) Minimizing sudden rate changes on the filters.

6) Comparing length of filter runs and head loss development with filter effluent turbidities.
7) Routine inspections for gravel mounding, mud balls, bed cracking, media growth, and media loss.
8) Checking for even flow distribution during backwash.

Many plants have been shown to operate more effectively from a water quality standpoint if the overall treatment rate is reduced. A reduction in the plant operating rate should be considered whenever monitoring shows degradation of treated water quality. Reductions in rates should also be considered during periods of adverse raw water quality or cold water conditions. It may be necessary to establish a lower overall plant rating than previously set in order to ensure meeting plant treatment goals at all times.

If reclaim of backwash water is part of routine plant operations, extreme care must be given to this practice to ensure against lowering plant effluent quality. Should there be any question about meeting treatment goals as the result of reclaim operations, discontinuing this practice permanently is encouraged.

EMERGENCY OPERATING PROCEDURES

All treatment plants occasionally experience changes in raw water quality that cause treatment goals to be exceeded. Experience has shown that brief periods of ineffective treatment can cause a cryptosporidiosis outbreak. Our discussions with water treatment plant superintendents emphasized the need to review in advance any procedures that may be effective in dealing with adverse changes in water quality. In particular, it was emphasized that information must be shared among operators in a treatment plant so that proper emergency procedures are implemented regardless of the operator on duty. It is recommended that each plant prepare a specific list of procedures for dealing with the various types of adverse treatment conditions that have previously been encountered. Plant staff are encouraged to review past operating history to evaluate the effectiveness of previous responses to these conditions so as to more quickly implement an effective treatment regime.

A number of emergency procedures were emphasized when treatment goals are being exceeded. They include:

1) Temporary plant shutdown.
2) Slowing treatment rates.
3) Stopping reclaim of backwash water.
4) Monitoring individual filter turbidities.
5) Filtering to waste.
6) Hand dosing of coagulant onto filters.
7) Use of anionic or non-ionic polymer filter aids.
8) Increasing disinfectant dose.
9) Increasing monitoring frequencies.

REFERENCES

The following recent articles and/or conferences focused on optimizing water treatment operations. It is strongly recommended that water plant officials review these article and conference outlines to help assess the overall performance of their plants and to better determine what areas of the overall operations and facilities need improvements or corrections.

1. "Assessing Treatment Plant Performance"; William D. Bellamy, John L. Cleasby, Gary S. Logsdon, and Martin J. Allen; Journal AWWA, Vol 85, December 1993, pp. 34-38.

2. "Preventing Waterborne Disease: How to Optimize Treatment", Participant Guide, AWWA Satellite Teleconference, September 9, 1994.

3. "Chicago, Bulls, and Cryptosporidium", AWWARF Technology Transfer Conference, Conference Outline, October 14, 1993.

DETERMINING PEAK DEMANDS FOR SMALL WATER SUPPLIES

A properly designed water supply system should deliver water at the desired quantity, quality, and pressure to any outlet on the system during the periods of heaviest use. To accomplish this, the peak demand is calculated and the well and pump and storage are sized to meet or exceed the demand.

Factors such as building type, future expansion or use of the establishment, hours of water usage, and any water use characteristics unique to the proposed establishment type must be considered if water demand figures are to be reliable. When yield criteria for public water supplies is specified by rule or policy, the system must be designed in accordance with those requirements.

The methods for determining peak demand discussed below are based on estimated water usage. Confidence in the water usage figures may be greater if more than one method is used for the proposed water supply and a comparison indicates the peak demand to be similar. The three sizing methods discussed below should be used for each proposed facility whenever possible. For large water supply systems, water pumpage records are necessary for determining peak usage, since it is impractical to perform fixture assessments.

Fixture Count Method

This method involves counting the number of fixtures and water outlets in the proposed building and multiplying by the peak demand per fixture indicated in Table 1. The resulting figure represents the total peak demand or recommended pump capacity for the building. The figures in Table 1 are based on the probability that as the number of fixtures increases, the relative number in use at any one time decreases.

EXAMPLE

> A 25 unit motel has been proposed. Each unit will have a water closet (tank type), lavatory, and shower. In addition, two hose bibb connections (5/8") will be used for lawn sprinkling. A total of 77 fixtures have been proposed. Table 1 indicates a peak demand of .50 gpm per fixture. 77 x .50 gpm = 38.5 gpm. Therefore, the minimum desired pump capacity should be 38 or 39 gpm.

TABLE 1

PEAK DEMAND IN GALLONS PER MINUTE (GPM) PER FIXTURE

Type of Building	Total Number of Fixtures							
	25 or less	26-50	51-75	76-100	101-200	201-400	401-500	over 500
Hospitals	1.00	1.00	.80	.70	.60	.50	.45	.40
Churches, Halls, Theaters	1.50	1.25	1.00	.80	.75	.70	.60	.50
Merchantile Buildings	1.30	1.00	.80	.75	.70	.60	.55	.50
Office Buildings	1.20	.90	.75	.70	.65	.50	.40	.35
Factories, Warehouses	1.25	1.00	.80	.75	.70	.60	.55	.50
Schools	1.20	.85	.70	.65	.60	.55	.45	.45
Motels, Hotels	.80	.65	.55	.50	.45	.40	.35	.30
Apartment Buildings	.60	.55	.50	.40	.35	.30	.25	.20

NOTE: For buildings with less than 25 fixtures, the pump capacity should be a minimum of 10 gpm. Where laundries or swimming pools are to be supplied, an additional 10% should be added to the pump capacity. Where additional water is required for heating, cooling, or other special processes, the water usage should be added to the pump capacity.

Residential Unit Method

Estimated peak demand flow for schools, motels, office buildings, churches, apartment complexes, and similar type buildings can be determined using data from similar systems of comparable size and usage. Where the total gallons per day water usage can be estimated, the peak demand can be determined using a basic formula derived from studies of water use patterns for residential customers. If actual data from similar buildings is not available, an estimate of daily water usage for various establishment types can be obtained from Table 2.

Using the Residential Unit Method, the flow rate in gpm is equivalent to 10 times the square root of the number of residential units served; therefore, gpm $= 10\sqrt{N}$. A residential unit (N) is equivalent to 350 gallons per day. Ten (10) gpm is recommended as a minimum pump capacity for non-community water supplies. Therefore, if the Residential Unit Method indicates less than 10 gpm as the peak demand, 10 gpm should be used as the minimum pump capacity.

EXAMPLE

An office building to accommodate 80 workers is proposed. The building will be used for one 8-hour work shift. Table 2 indicates a flow of 15 gallons per day per person per work shift. This gives a total daily flow of 80 workers x 15 gallons per day (gpd), or 1200 gpd. $1200 \div 350 = 3.42$ residential units; gpm $= 10\sqrt{3.42} = 18.5$. Therefore, the minimum desired pump capacity should be 18 or 19 gpm.

TABLE 2
ESTIMATED DAILY WATER USAGE*

Type of Establishment	Gallon Per Person Per Day (Unless Otherwise Noted)
Airports (per passenger)	5
Bathhouses and swimming pools	10
Camps:	
Campgrounds	**
Construction camps (semi-permanent)	50
Day camps (no meals served)	15
Resort camps (night and day) with limited plumbing	50
Luxury camps	100
Church (per auditorium seat)	5
Church (with substantial kitchen wastes, per auditorium seat)	7-10
Cottages and small dwellings with seasonal occupancy	50
Country clubs (per resident member)	100
Country clubs (per non-resident member present)	25
Dwellings:	
Boarding houses	50
additional for non-resident boarders	10
Luxury residences and estates	150
Multiple family dwellings (apartments)	80
Rooming houses	40
Single family dwellings	75
Factories (gallons per person, per shift, exclusive of industrial wastes)	35
Hospitals (per bed space)	250+
Hotels with private baths (2 persons per room)	60
Hotels without private baths	50
Institutions other than hospitals (per bed space)	125
Laundries, self-service (gallons per wash, i.e., per customer)	50
Mobile home parks (per space)	**
Motels with bath, toilet, and kitchen wastes (per bed space)	50
Motels (per bed space)	40
Picnic parks (toilet wastes only) (per picknicker)	5
Picnic parks with bathhouses, showers, and flush toilets	10
Schools:	
Boarding	100
Day, without gyms, cafeterias, or showers	15
Day, with gyms, cafeteria, and showers	25
Day, with cafeteria, but without gyms or showers	20
Service stations (per vehicle served)	10
Swimming pools and bathhouses	10
Theaters:	
Movie (per auditorium seat)	5
Drive-in (per car space)	5
Workers:	
Construction (at semi-permanent camps)	50
Day, at schools and offices (per shift)	15

*Based on quantities of sewage flow. Does not include demand for lawn sprinkling, ground water heat pumps, and other water using equipment not connected to a sewer. Figures for such equipment should be added to the peak demand to determine desired minimum capacity.

Fixture Method

The Fixture Method should be used for determining peak demands for food service establishments. A list of water using fixtures may be obtained from architectural plans submitted to the local health department for review. The Fixture Method may also be used for facilities not listed in Table 2, or where it is felt that flow rates in Table 2 are inaccurate or unreasonable. The Fixture Method utilizes a list of commonly used water fixtures, where each is assigned a value which reflects the demand producing effect on the system (Table 3). The sum of the combined values for all fixtures is then adjusted (Graph 1) to compensate for the probability that as the number of fixtures increases, the relative number in use at any one time decreases. The result is a peak demand flow and a basis for establishing a minimum pump capacity.

Step 1: Determine the number of each type of water using fixture to be served by the proposed water supply.

Step 2: Multiply the number of each fixture type by its assigned fixture value (from Table 3) to determine the fixture value total.

Step 3: Add up the various fixture value totals to obtain the establishment fixture value. Do not include outside hose bibbs which may supply water for lawn sprinkling.

Step 4: Apply the establishment fixture value to the curve of either Graph 1 or Graph 2 to determine the estimated peak demand.

Step 5: Fixture values (gpm flow) for outside hose bibbs which may provide water for lawn sprinkling during peak water usage periods should be added directly to the estimated peak demand as determined in Step 4. This will determine the desired minimum pump capacity.

EXAMPLE

A small food service establishment is proposed with the following fixtures:

FIXTURE TYPE	NUMBER OF FIXTURES	FIXTURE VALUE	FIXTURE VALUE TOTAL
Water closets, tank	3	5	15
Lavatories	3	3	9
Kitchen sink, small	1	6	6
Kitchen sink, large	1	8	8
Service sink	1	10	10
Garbage disposal	1	5	5
Ice machine	1	2	2
Establishment fixture value:			55
Hose bibb (outside), 5/8" conn.	1	5	5

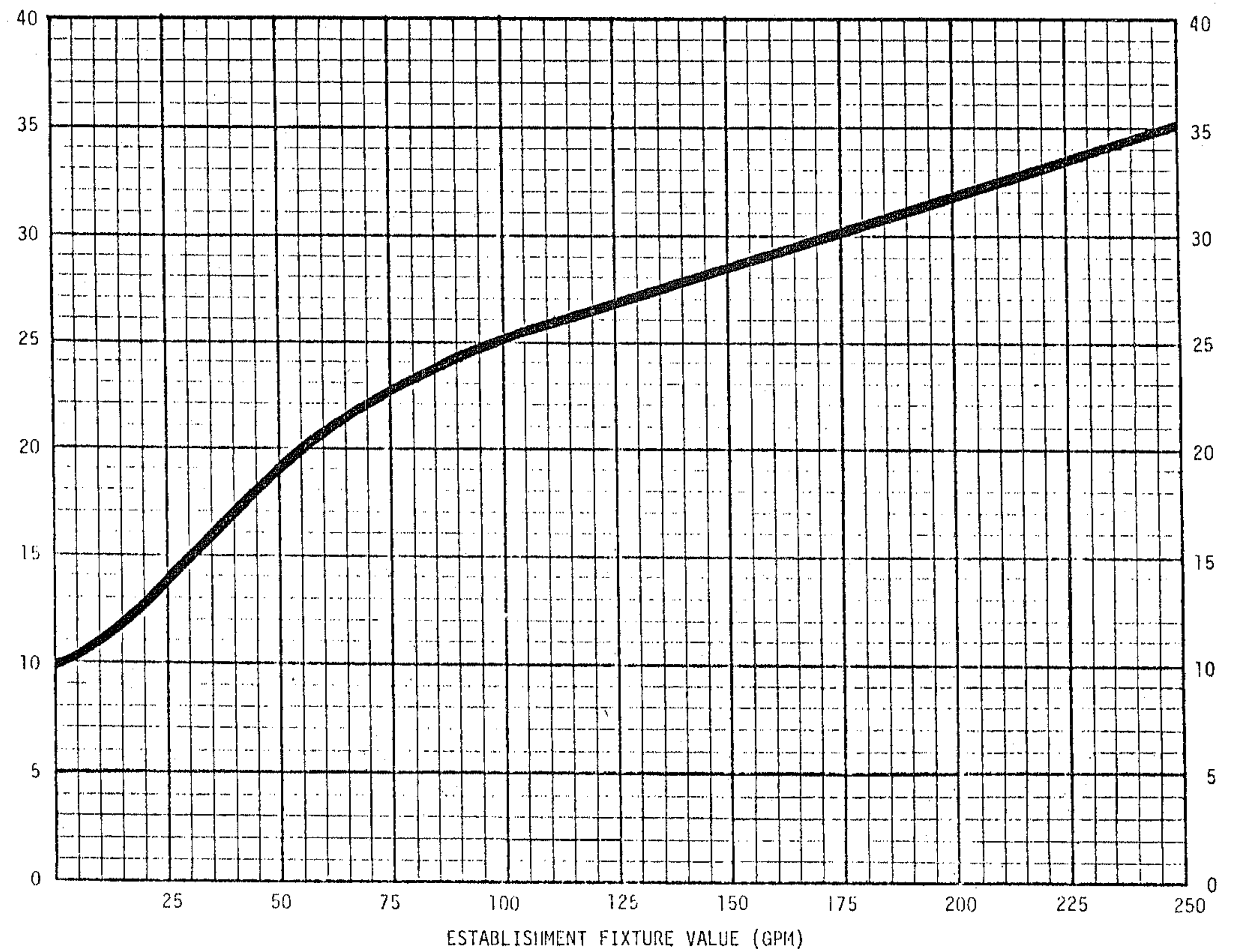
Using Graph 1, the estimated peak demand based on an establishment fixture value of 55 is equal to 20 gpm. The 5 gpm demand for the 5/8" outside hose bibb must be added to the 20 gpm. Therefore, the minimum desired pump capacity should be 25 gpm.

TABLE 3
FIXTURE VALUES

FIXTURE TYPE	FIXTURE VALUE (GPM FLOW)
Water closet, with tank	5
Water closet, with flush valve	27
Urinal, with tank	4
Urinal, with flush valve	15
Lavatory	3
Bathtub, or tub/shower combination	10
Shower	6
Drinking fountain	2
Hose bibb or yard hydrant, 1/2" connection	3
5/8" connection	5
3/4" connection	10
Washing machine, 1/2" connection	3
5/8" connection	5
3/4" connection	10
Laundry tray	8
Lawn sprinkler, per sprinkler head	5
Auto washing, hand spray type	5
Tractor and equipment washing	5
Water softener regeneration	7
Dental unit	1
Dental lavatory	2
Garbage disposal, domestic	3
commercial	5
Kitchen sink, small	6
large	8
Spray rinse, hand operated	4
Ice machine	2
Ice cream machine	2
Ice cream dipperwell	2
Glass filling unit	2
Hot chocolate unit	0.5
Coffee urn	0.5
Service sink	10

NOTE: Demand for lawn sprinkling and water softening regeneration operating at times other than business hours of establishment may be eliminated from calculations. Fixture values for other water using equipment, such as groundwater heat pumps, air conditioners, evaporative coolers, etc., will vary with the size of the unit. Consult manufacturers' specifications to determine flow rate. These flow rates should be added directly to the peak demand as in Step 5 on p. 4.

GRAPH 1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10
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25
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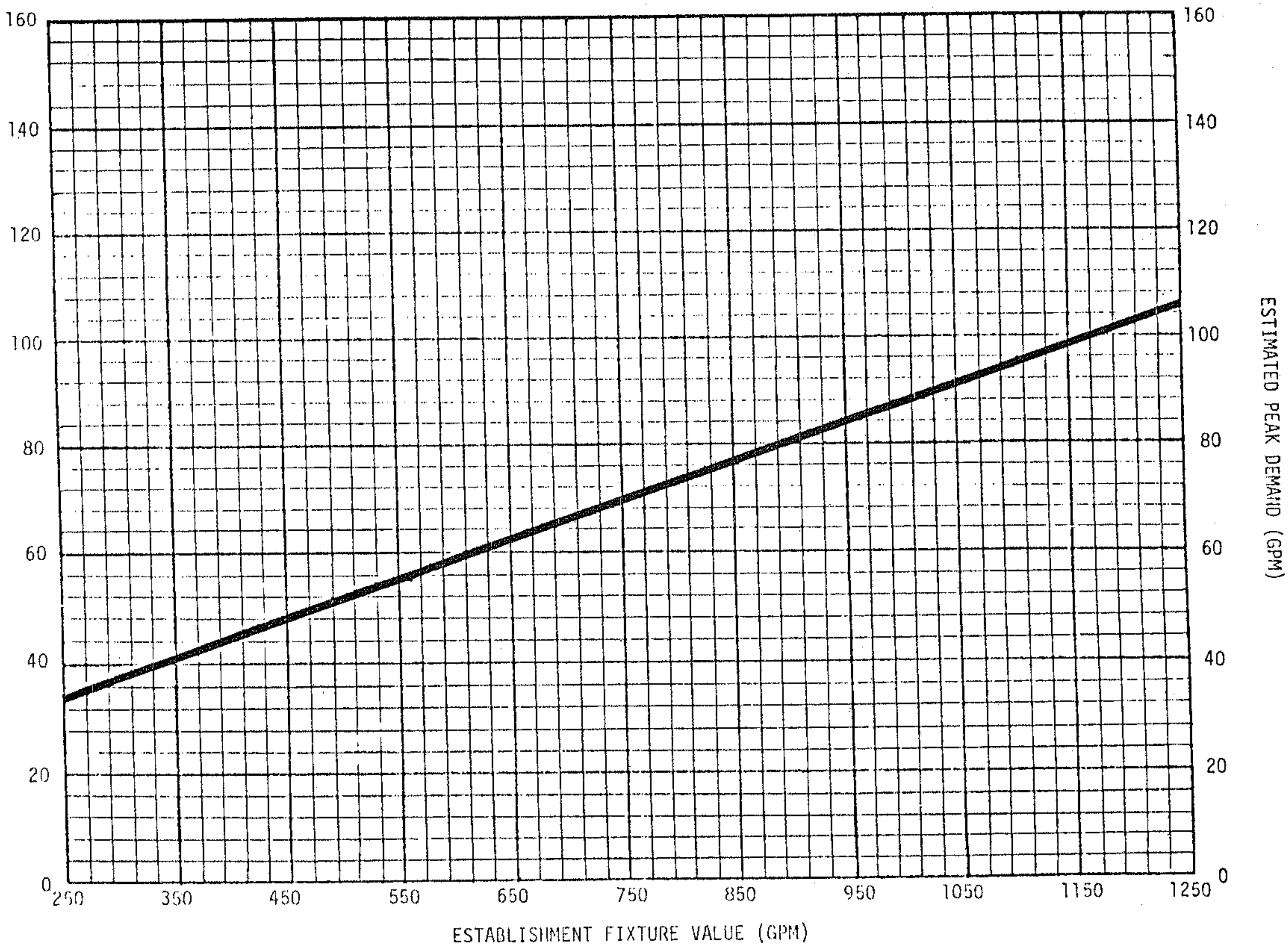
ESTABLISHMENT FIXTURE VALUE (GPM)
ESTIMATED PEAK DEMAND (GPM)

GRAPH 2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80
60
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250
350
450
550
650
750
850
950
1050
1150
1250
ESTABLISHMENT FIXTURE VALUE (GPM)
ESTIMATED PEAK DEMAND (GPM)