NITRIFICATION ACTION PLAN IMPLEMENTATION & OUTCOMES

WHAT WE ARE GOING TO DISCUSS TODAY

The Regulatory Requirement?	What Is Required?	Does The Plan Really Do Anything?	Has A NAP Made a Difference to Anyone?
• Why the Regulation? • Why the Confusion?	• But, I Reach Breakpoint! • I Sample, But What Else Do I Need to Do?	• The Reg just says I have to Monitor and Have a Plan!	• -A Couple Case Studies.

WHY THE REGULATION?

- ILLINOIS PCB RECOGNIZED DISTRIBUTED WATER QUALITY DEGRADATION IN MANY COMMUNITIES
  - Loss of Disinfectant
  - Taste and Odor
  - Vulnerability to Pathogens (e.g., Legionella)
- ILLINOIS EPA STAFF WERE AWARE MANY WATER SYSTEMS DID NOT UNDERSTAND THE TYPE OF DISINFECTANT THEY WERE USING OR THEIR WATER CHEMISTRY
  - Groundwater systems with free ammonia were not necessarily reaching a free residual and were employing chloramination or bouncing around breakpoint
  - Systems purchasing chloraminated water unaware of the concentrations of free ammonia they were receiving in and were often adding chlorine without monitoring their chlorine to free ammonia ratios

WHAT THE REGULATION SAYS:

WHY THE CONFUSION?

- How much free ammonia, iron, manganese, TOC, hydrogen sulfide is present in your source water?
  - How do you know you are overcoming chlorine demand?
- Some may misunderstand the regulation.
  - Free ammonia does not dictate the need for a NAP!
  - Presence of free ammonia dictates confirmation that breakpoint is achieved and maintained.

SECTION 604.140 NITRIFICATION ACTION PLAN

ANY COMMUNITY WATER SUPPLY DISTRIBUTING WATER WITHOUT A FREE CHLORINE RESIDUAL MUST CREATE A NITRIFICATION ACTION PLAN (NAP). THE NAP MUST:

A) CONTAIN A PLAN FOR MONITORING TOTAL AMMONIA-N, FREE AMMONIA-N, NITRITE-N, NITRATE-N, MONOCHLORAMINE RESIDUAL, DICHLORAMINE RESIDUAL, AND TOTAL CHLORINE RESIDUAL;

B) CONTAIN SYSTEM SPECIFIC LEVELS OF THE CHEMICALS IN SUBSECTION (A) WHEN ACTION MUST BE TAKEN;

C) CONTAIN SPECIFIC CORRECTIVE ACTIONS TO BE TAKEN IF THE LEVELS IN SUBSECTION (B) ARE EXCEEDED; AND

D) BE MAINTAINED ON SITE AND MADE AVAILABLE TO THE AGENCY, UPON REQUEST.

WHEN IS A NAP REQUIRED?

- If you don't breakpoint chlorinate, you need a NAP
- If you purchase chloraminated water, you need a NAP
- If your source water has free ammonia, you need to demonstrate what type of residual you are using, you <u>may</u> need a NAP
    - How do I document our disinfection practice?

DOCUMENT YOUR DISINFECTION PRACTICE

- Do the math:
  - Overcome competition for chlorine and other reactions.
  - Generally, chlorine reactions follow this sequence: 1) Iron, Hydrogen Sulfide, etc.; 2) free ammonia; 3) monochloramine and dichloramine. To establish a free chlorine residual, need to overcome:
    - Manganese at 1.3 times Mn concentration,
    - Iron at 0.64 times Fe concentration,
    - Sulfide at 2.2 times H_2S concentration,
    - Ammonia times at 7.6 times NH_4 concentration
    - (and don't forget possible TOC interaction to form DBPs).

HOW DO I KNOW IF I HAVE AMMONIA IN MY GROUNDWATER SOURCES

FIRST STEP IS GO TO THE DRINKING WATER WATCH WEBSITE

- [HTTPS://WATER.EPA.STATE.IL.US/DWW/INDEX.JSP](https://water.epa.state.il.us/DWW/index.jsp)

SECOND STEP CONDUCT CONFIRMATION MONITORING

- DATA MAY BE OLD AND DOES CHANGE

Links

- Water System Facilities
- Sample Schedules
- Coliform/Microbial Sample Results
- Coliform Sample Summary Results
- Lead And Copper Sample Summary Results
- Chem/Rad Samples/Results
- Chem/Rad Samples/Results by Analyte
- Violations/Enforcement Actions
- Site Visits
- Milestones

Return Links

- Water Systems
- Water System Search
- County Map

Glossary

Water System Details

Water System No. :	IL0950450	**Federal Type :**	C
Water System Name :	RIO	**State Type :**	C
Principal County Served :	KNOX	**Primary Source :**	GW
Status :	A	**Activity Date :**	01-01-1958

Points of Contact

Name	Job Title	Type	Phone	Address	Email
SHULL, BOB L.	OPERATOR	AC	309-373-9858	262 -340TH STREET, RIO, IL-61472	shullwtr@gmail.com
SHULL, BOB L.		SA	309-373-9858	ROUTE #1, BOX 164, RIO, IL-61472	shullwtr@gmail.com
NOE, KIMBERLEY D	VILLAGE PRESIDENT	OC	309-294-4767	318 N. Main, RIO, IL-61472	kheinec2@gmail.com

Annual Operating Periods & Population Served

Start Month	Start Day	End Month	End Day	Population Type	Population Served
1	1	12	31	R	265

Service Connections

Type	Count	Meter Type	Meter Size Measure
RS	106	ME	0

Sources of Water

Name	Type Code	Status
WELL 1 (50129)	WL	A
WELL 2 (50130)	WL	A

Service Areas

Code	Name
R	MUNICIPALITY

1032	MANGANESE	IOC
1035	MERCURY	IOC
2015	METHOXYCHLOR	OC
2251	METHYL TERT-BUTYL ETHER	OC
1036	NICKEL	IOC
1040	NITRATE	IOC
1038	NITRATE-NITRITE	IOC
1041	NITRITE	IOC
1003	NITROGEN-AMMONIA AS (N)	IOC
2968	O-DICHLOROBENZENE	OC
2036	OXAMYL	OC
2969	P-DICHLOROBENZENE	OC
2326	PENTACHLOROPHENOL	OC
1925	PH	WQ
2040	PICLORAM	OC
1045	SELENIUM	IOC
1050	SILVER	IOC
2037	SIMAZINE	OC
1052	SODIUM	IOC
2996	STYRENE	OC

SOME OF YOU MAY HAVE SEEN THIS REPORT

OR ACCESSED THE LINK BELOW TO DEVELOP YOUR OWN EVALUATION

- HTTPS://WWW.ILRWA.ORG/DOWNLOADS/NAP.HTML

Bluffs (IL1710100)
DISINFECTION PRACTICE FINAL REPORT
09/27/2023
Provided by the Illinois Rural Water Association

The purpose of this report is to provide information that augments the data maintained by Bluffs that documents the status of its disinfection practices. More specifically this document is intended to provide the necessary details to substantiate the type of disinfectant that is assuredly and continuously provided to the Village's customers. As related below, the calculated chlorine demand and monitoring data collected by the Illinois Rural Water Association (Association) on September 7, 2023, confirms that a free residual is established, and concentrations meet regulatory requirements.

Background
The Bluffs community water supply utilizes three sand and gravel wells as its source of water. Wells 3 (58061) 5 (01315) and 6 (01316) supply approximately 130,000 gallons per day to consumers. Water from the wells is treated with a 12.5% sodium hypochlorite solution and passed through green sand filters. Prior to discharge to the ground storage tank water is fluoridated. Distribution system water pressure is maintained by high service pumps obtaining water from an 80,000-gallon ground storage tank (soon to be replaced by a 150,000-gallon tank). The community water supply directly serves approximately 290 customers (approximately 700 individuals) and provides bulk water to the Exeter-Meret Water Coop.

Chlorine (Cl_2) demand is defined as the difference between the Cl_2 remaining (after contact time) and the Cl_2 added to the water. The demand on the Cl_2 added to a water supply will be dependent on contact time, temperature, and pH. When calculating demand, the reaction of Cl_2 with dissolved/suspended organic matter and inorganic chemicals must be considered. The reaction with organic material forms disinfection biproducts (TTHMs and HAAs). The reactions with inorganic chemicals form ferrous, manganous, nitrite, sulfide and sulfide ions. Additionally, the ammonia contained in the source water will react with Cl_2 to form chloramines. Generally, overcoming these competing reactions requires the following:

- Iron will consume 0.64 times its concentration (mg/l) in Cl_2;
- Manganese will consume 1.3 times its concentration (mg/l) in Cl_2;
- Hydrogen Sulfide will consume 2.2 times its concentration (mg/l) in Cl_2; and
- Ammonia will consume 7.6 times its concentration (mg/l) in Cl_2.

Chlorine Requirement:
The chlorine requirement of a particular water is defined as the Cl_2 needed to meet regulatory requirements in all areas of a water supply distribution system. In Illinois, this requirement is either 0.5 mg/l of "free" chlorine or 1.0 mg/l of "total" chlorine. *

**Reference:*
Title 35 IL Adm. Code 604.725 Residual Chlorine
a) A minimum free chlorine residual of 0.5 mg/L or a minimum combined chlorine residual of 1.0 mg/L must be maintained in all active parts of the distribution system at all times.
b) Community water supplies must monitor chlorine residual to determine the amount and type of residuals existing at different points in the distribution system.
c) Community water supplies must not mix water sources with free chlorine and combined chlorine

YOU MAY HAVE SOMETHING THAT LOOKS LIKE THIS

Average Water Age NAP Monitoring Record

Nitrification Action Plan For: BEARDSTOWN

7-Digit ID Number: IL 0170150
7-Digit ID Number

Description of Sample Location: MAINTENANCE BUILDING
Site I.D. — *Local Description of Sample Location*

	Total Cl (mg/l)	Free Cl* (mg/l)	Mono-Chloramine (mg/l)	Di-Chloramine (mg/l)	Total NH3-N (mg/l)	Free NH3-N (mg/l)	Nitrite-N (mg/l)	Nitrate-N (mg/l)
Sample Frequency	Daily	Daily (during burn)	Weekly	Monthly	Weekly	Weekly	Monthly	Monthly
Goal.mg/L	3.75	0.00	3.40	0.25	A**	2.00		
Yellow Alert Trigger, mg/L	3.00	0.00	2.70	0.30	B**	3.50		
Action Code								
Red Alert Trigger, mg/L	2.50	0.00	2.25	0.35	C**	4.00		
Action Code								

Date	By	Total Cl	Free Cl*	Mono-Chloramine	Di-Chloramine	Total NH3-N	Free NH3-N	Nitrite-N	Nitrate-N
5/25/2022	IRWA	3.10		2.99			2.70	< LIMIT	

IF NOT, YOU CAN GET HELP AT THE LINK NOTED PREVIOUSLY

IF YOU ARE NOT USING FREE CHLORINE, THEN:

YOU MUST FOLLOW THE NAP REGULATION:

- Monitor for Nitrite, Nitrate, Monochloramine and Total Chlorine
- Triger Levels that Prompt Actions
- Corrective Actions
- Maintain the Plan and Data On-site for Illinois EPA Review

WHAT IS IN IT FOR ME, AKA THIS LOOKS LIKE ANOTHER PAPER TIGER

- NAP Can Provide the Basis/Cover for Actions You May Already be Taking
  - Deep Cycling Your Storage to the Displeasure of the Fire Department
  - Reducing the Quantity of Stored Water (Dropping the Water Level in the Tower), again, to the Disapproval of the Fire Department
  - Flushing even Though the Mayor and Customers Think You are Wasting Water
  - Making Changes to Your Distribution System
    - Auto flushers, tank mixers, looping mains, etc.

EXAMPLES OF WHAT MONITORING CAN TELLS US

Are Your Chlorination Practices Optimized (Start with a 5 to 1 chlorine to Ammonia-N ratio)

Measure Monochloramine, Total Chlorine and Free Ammonia at the entry point and in the distribution system.

- At the entry point to the distribution system:
  - If Mono=Total and no free ammonia you have optimized.
  - If free ammonia is still present, increase chlorine feed (up to NSF limit) and remeasure.
  - If total higher than mono and no free ammonia, decrease chlorine feed and remeasure.
- In the distribution system (assuming optimized disinfection)
  - Mono less than total and free ammonia present - mono degrading to di
  - Ammonia present - After chloramines are formed, they begin to decay and release ammonia back into the water. As decay occurs, monochloramine is converting to dichloramine and then dichloramine begins to dissipate. As pH drops, the rate of dichloramine formation is more rapid and it lasts longer in the water. (may get taste and odor complaints at the point di becomes prevalent). Also, some systems cannot use up all of the free ammonia present!

DATA IMPORTANCE CONTINUED

Watch for nitrite and nitrate formation to help determine if nitrification is occurring

- Measure at the source, entry point and designated points in the distribution system

Optimize pH –

- Chloramines are more stable (long lasting) at higher pH and nitrifying bacteria are generally less likely to form at higher pH (9.0+).
- Measure pH at the entry point to the distribution system and in the distribution system
  - A decrease in pH could indicate the presence of nitrifiers
  - Important note on nitrate and pH – U.S. EPA ORD has determined that the presence of nitrifiers and lowered pH can be a significant factor in corrosion control. The processes at work may cause LCR violations and health risks if left unchecked.

IN SUMMARY, YOU MAY HAVE A NITRIFICATION PROBLEM IF:

The weather is hot, and the treated water has excess ammonia

Your monitoring indicates:

- Monochloramine levels are decreasing
- Ammonia-N concentrations are going down.
  - Decrease in free ammonia suggests that it is being “eaten” by nitrifying bacteria, converting it to nitrite then to nitrate. Often seen in groundwater systems that can’t optimize chloramination resulting in excess free ammonia in distributed water.
- Nitrite/ntrate concentrations are increasing
- You begin receiving taste and odor complaints because dichloramine concentrations are going up as mono decays
- pH drops in the distribution system

WHAT SHOULD MY GOALS BE FOR DISTRIBUTION SYSTEM WATER QUALITY

Maintain monochloramine residual above 1.5 mg/L. (AWWA M-56)

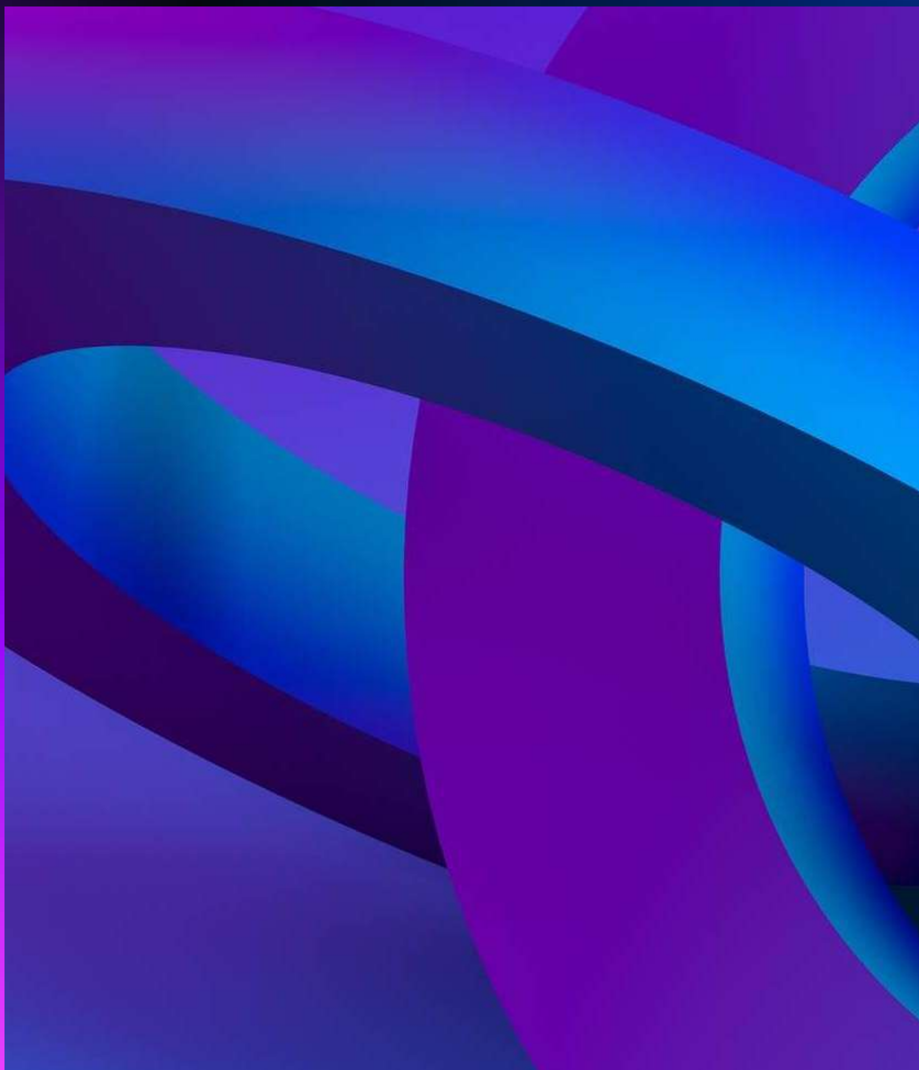
Minimize water age. (Flushing, Tank cycling. Looping mains. Properly sized mains and storage.)

Re-chloramination may be necessary if you are purchasing your water. (Not just chlorine addition.)

Semi-Annual “burn-out” is advisable. (Switch to free chlorine residual, with hard flushing, 1 to 3 volumes.)

MUST MONITOR WATER QUALITY PARAMETERS to stay on top of nitrification!

- The lower the monochloramine residual, the greater risk that nitrification will develop.
- Some states require (e.g., Texas) dead end flushing once/month (may not be enough).
- Let your data drive your actions.



CASE STUDIES

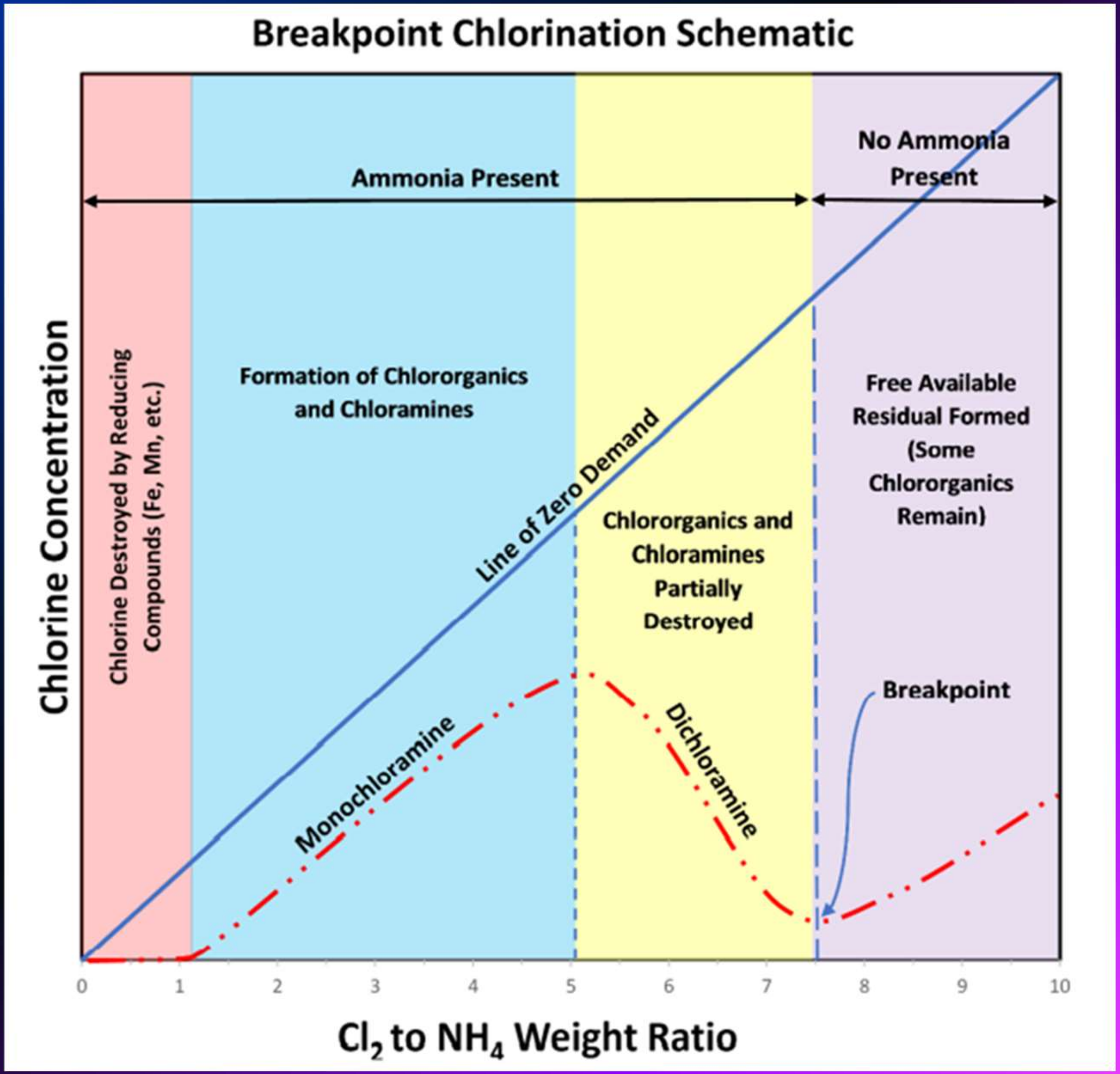
Water system with free ammonia that has the flexibility to chloraminate are use free chlorine residual.

Groundwater system that must practice chloramination.

Purchase water system that must practive chloramination and free chlorine burns.

CASE STUDY 1

The community utilizes two bedrock wells as its source of water. Water from the wells is aerated and discharged to a 12,500-gallon ground storage tank following the addition of a 12.5% sodium hypochlorite solution. From the tank, water is pumped into the distribution system.   Water pressure is maintained by a 100,000-gallon elevated storage tank. On average, the water treatment facility supplies approximately 46,000 gallons per day to approximately 364 metered customers (676 individuals).



DO THE MATH TO DETERMINE REQUIRED CHLORINE

To Achieve a Free Residual

DWW Data 8/20/2013	Iron mg/l	Iron Demand mg/l	Manganese mg/l	Manganese Demand mg/l	Ammonia mg/l	Ammonia Demand mg/l	Total Demand mg/l	Chlorine Requirement mg/l
	a	a mg/l x .64 = A	b	b mg/l x 1.3 = B	c	c mg/l x 7.6 = C	A + B + C = D	D + Target mg/l= Cl_2 Requirement
Well 3 (55025)	.050	.050 x .64 = .032	< . .015	.015 x 1.3 = .0195	0.959	0.959 x 7.6 = 7.288	.032 + .0195 + 7.288 =	7.012 + .5 = 7.340
Well 4 (01940)	.119	.119 x .64 = .076	< . .015	.015 x 1.3 = .0195	.916	0.916 x 7.6 = 6.96	.076 + .0195 + 6.96 = 7.055	7.055 + .5 = 7.556

To Chloraminate

	Iron mg/l	Iron Demand mg/l	Manganese mg/l	Manganese Demand mg/l	Ammonia mg/l	Ammonia to Chlorine Optimum Ratio mg/l	Total Demand and Chlorine Requirement mg/l
	a	a mg/l x .64 = A	b	b mg/l x 1.3 = B	c	c mg/l x 5.1 = C	A + B + C = D
Well 3 (55025)	.050	.050 x .64 = .032	< . .015	.015 x 1.3 = .0195	0.959	0.959 x 5.1 = 4.891	.032 + .0195 + 4.891 = 4.943
Well 4 (01940)	.119	.119 x .64 = .076	< . .015	.015 x 1.3 = .0195	0.916	0.916 x 5.1 = 4.672	.076 + .0195 + 4.672 = 4.768

Note: In theory, roughly 1 mg/l of free ammonia should nearly satisfy the 1.0 mg/l “regulatory” chlorine requirement for total chlorine as well as occupying as much free ammonia as possible (minimizing nitrification within distributed water):

FREE CHLORINE

$$lbs/Day = \frac{(MGD)(mg/l)(8.34)}{Purity\ (\%\ as\ a\ Decimal)}$$

Well 3:

$$lbs/Day = \frac{(.046\ MGD)(7.34\ mg/l)(8.34)}{.125\ Purity\ (\%\ as\ a\ Decimal)}$$

= 22.52 lbs. / day

Well 4:

$$lbs/Day = \frac{(.046\ MGD)(7.56\ mg/l)(8.34)}{.125\ Purity\ (\%\ as\ a\ Decimal)}$$

= 23.2 lbs. / day

MONOCHLORAMINE

$$lbs/Day = \frac{(MGD)(mg/l)(8.34)}{Purity\ (\%\ as\ a\ Decimal)}$$

Well 3:

$$lbs/Day = \frac{(.046\ MGD)(4.943\ mg/l)(8.34)}{.125\ Purity\ (\%\ as\ a\ Decimal)}$$

= 15.17 lbs. / day

Well 4:

$$lbs/Day = \frac{(.046\ MGD)(4.768\ mg/l)(8.34)}{.125\ Purity\ (\%\ as\ a\ Decimal)}$$

= 14.63 lbs. / day

	<u>Pros</u>	<u>Cons</u>
Free (break point) chlorination:	Potentially easier to consistently achieve/maintain since once break point is achieved more chlorine increases residual levels.	Additional chemical expense.
	Nitrification Action Plan (NAP) is not required.	Free residual does not last as long in the distribution system as a monochloramine residual.
	Because NAP not required, additional testing equipment will not be required (although it would be beneficial).	
Total (monochloramine) chlorination:	Reduced chemical cost with optimization.	NAP requirement.
	Residuals not as affected by water age.	Additional testing equipment will need to be purchased.
	Arguably, NAP testing may provide better process control.	Additional time will be needed to run additional NAP tests.

CASE STUDY 2

This community water system serves a population of 6,123 individuals or roughly 2,031 customers. Water is obtained from four drilled drift wells (that all produce approximately 700 gallons per minute). The groundwater supplied by the wells is treated with chlorine gas and potassium permanganate. The water supply is then filtered and treated with sodium fluoride and phosphate and discharged to the distribution system and three elevated storage tanks (capacities of 50,000, 500,000 and 1,000,000 gallons). On average, the water system treats approximately 500,000 gallons per day.

WATER QUALITY

Iron Range: 3.18 to 4.22 mg/l

- Cl_2 Demand: 4.220 x .64 = 2.700

Manganese Range: 0.226 to 0.512 mg/l

- Cl_2 Demand: 0.512 x 1.3 = .666

Nitrogen NH_3 as N Range: 0.235 to 12.0 mg/l

- Cl2 Demand Worst: 12.00 x 7.6 = 91.2 mg/l
- Cl2 Demand Best: .235 x 7.6 = 1.786 mg/l

System rotates well production by pumping Well 1 and 2 then Well 3 and 4. Assuming an average production of 500,000 gallons per day from an average chlorine requirement of the described well rotation and 100% purity chlorine gas (the target concentration of .5 mg/l is included in the table), the following result is obtained:

Well 1 and 2:

lbs/Day=(.500 MGD)(47 mg/l)(8.34)/(1.0 Purity (% as a Decimal)) = 196 lbs. / day

Well 3 and 4:

lbs/Day=(.500 MGD)(53.144 mg/l)(8.34)/(1.0 Purity (% as a Decimal)) = 221 lbs. / day

Since the system treats its water to reduce the concentration of iron and manganese, assuming the "TAP" information above, we can generalize that iron and manganese demand is negligible compared to the demand of free ammonia on the chlorine gas. Assuming an average production of 500,000 gallons per day and using the measured free ammonia data collected by IRWA for Well 1 and 2 and the average data from Well 3 and 4 from Drinking Water Watch (plus the .5 Illinois EPA chlorine requirement), we can estimate the it would take the following Cl_2 to reach breakpoint:

Well 1 and 2:
lbs/Day=(.500 MGD)(36.22 mg/l)(8.34)/(1.0 Purity (% as a Decimal)) = 151 lbs. / day

Well 3 and 4:
lbs/Day=(.500 MGD)(50.13 mg/l)(8.34)/(1.0 Purity (% as a Decimal)) = 209 lbs. / day

NOT PRACTICAL

Based upon these calculations, practicing breakpoint chlorination is impractical.

- Levels of chlorine gas would exceed the maximum NSF chlorine gas concentration of 30 mg/l (as Cl_2). (Note: NSF for Sodium Hypochlorite is 10 mg/l)

Therefore, with the existing treatment options, System must practice chloramination.

- Add enough Cl_2 to establish the maximum total residual of 4 mg/l or about 20.4 mg/l
  - System's average free ammonia concentration of 6.25 mg/l,
    - Therefore, 2.25 mg/l of free ammonia will remain following chemical addition (based upon available monitoring data).
    - The following is an estimation of the amount of Cl_2 needed under the previously described conditions:

      lbs/Day=(.500 MGD)(20.4 mg/l)(8.34)/(1.0 Purity (% as a Decimal)) =
      85 lbs. / day

WHAT TO DO?

Challenging situation. Distributed water is vulnerable to nitrification.

Short term considerations: Limit nitrification.

- Control chloramination process - produce water with 4.0 mg/l monochloramine
- Implement a nitrification action plan (NAP) to further evaluate and control treated water quality. Collecting water quality data over time will be invaluable in preventing uncontrolled nitrification that can have serious repercussions.
  - Included purchasing equipment to conduct all of the requisite testing.

Near term considerations: Evaluate NAP Data

- Continue current best practices to discourage nitrification of distributed water.
- Consideration should be given to increasing the frequency of directional flushing and deep cycling storage tanks. In a nutshell, water age is the enemy.

WHAT TO DO CONTINUED?

Near term considerations continued:

- As monitoring data is collected to further develop the NAP
  - NAP data should ultimately drive the actions
    - E.G., Monochloramine and total chlorine at the entry point to the distribution system (TAP 01) you can confirm that (if Mono = Total) the plant has reached the 4.0 mg/l goal.
    - Monitoring distributed water, large swings in water quality could be a precursor to significant problems.
    - Even small changes need to be evaluated, as described previously, as they may indicate a concern.

WHAT TO DO CONTINUED?

Long term considerations: Decrease Water Age

- Increase water turnover in storage tanks (such things as installing mixers, altitude valves, electrically controlled valves, simple SCADA, etc.).
- Increased flushing
- Eliminating dead-end water mains (i.e., looping mains) and installation of auto-flushers in low usage areas may be necessary.
- Use of an alternative disinfectant (e.g., chlorine dioxide)
- Other changes to treatment (e.g., ammonia removal) and/or a new source of water (i.e., new wells

CASE STUDY 3

The water system purchases approximately 40,000 gallons per day of water that it distributes to approximately 600 people. Pressure on the system is maintained by a 100,000-gallon elevated storage tank. The storage tank has a "tank mixer" and the distribution system is relatively new with extensive looping. The water system has the ability to boost chlorine (chlorine gas) at the entry point to to their distribution; however, ammonia cannot be injected.

WATER QUALITY

The community system purchases chloraminated treated surface water that, through NAP monitoring, has been determined to have variable concentrations of free ammonia. Further, disinfectant residuals of water received often change based upon the season of the year. Disinfection biproducts have not been a concern since the mixer was installed in the tank and since the wholesaler began to better coordinate their twice a year free chlorine burns. Water received also has a relatively high pH which may be a factor in inhibiting nitrification.

	The Good News	The Bad News
Source Water	Water received almost always meets 1.0 mg/l of total chlorine.	In the summer time, under normal operations, the monochloramine residual is significantly lower than the total residual.
Treated Water	Under normal operations, not during a free chlorine burn, there is available free ammonia to optimize chloramination through the chlorine booster station.	The system must flow pace chemicals because no tank is available to mix the influent water with chlorine (or future ammonia feed).
Distribution System	Water storage is sized reasonably well and has a tank mixer to further reduce water age. Water mains are largely looped.	While mains are looped they are oversized in certain areas requiring increased seasonal flushing.
Free Chlorine Burns	Twice a year burns appear to be an effective tool in limiting nitrification.	The wholesaler does not do a good job of pre-planning and the system often has difficulting achieving breakpoint in all areas of the distribution system and the converse.

NAP MONITORING OUTCOMES

The NAP provides information that wasn't previously known!

Short term considerations:

- Control chloramination process - adjust monochloramine based upon free ammonia received, not a guess that often put system on the "wrong side of the breakpoint curve."
- NAP is illustrating trends that can heighten responsiveness and gear actions to particular times of the year not to mention catching major water quality changes (e.g., a change to a free residual).
- NAP monitoring and DBP control drove installation of tank mixer which resulted in a significant improvement in water quality (complaints decreased)

Near term considerations: Continue to evaluate NAP Data

- Continue current best practices to discourage nitrification occurring in distributed water.
- Consideration should be given to increasing the frequency of directional flushing because of oversized water mains (NAP data seems to bear out that these areas have water age concerns)

NAP MONITORING OUTCOMES CONTINUED

Long term considerations: Continue to evaluate NAP Data

- If data indicates that an insufficient quantity of free ammonia is available in the purchased water and residuals are not meeting regulatory limits, the ability to feed ammonia may become a necessity
  - Flow pacing chemicals has proven to be challenging. Therefore, installation of a “mixing” tank should be considered along with the additional chemical feed.
- If data continues to bare out that oversized mains are creating a water quality problem, auto-flushers might be a less labor-intensive solution than traditional flushing. The techncology around these devices has improved substantially in recent years.
- If the wholesaler continues the practice of twice a year free chlorine burns, the system should develop a standard operating procedure for establishing a free residual and returning to chloramines.
  - The procedure needs to address stored and distributed water, in both cases.

THANK YOU