Massachusetts Department of Environmental Protection - Drinking Water Program

Reducing Chlorate: Best Management Practices and Management Practice Survey Results (Dec. 2017)

Introduction The Massachusetts Department of Environmental Protection (MassDEP), Drinking Water Program (DWP), has developed this document to assist Public Water Systems (PWS) to reduce chlorate as a disinfection byproduct in their drinking water. This document provides: background on chlorate in drinking water; best management practices to reduce chlorate levels; results of a 2016 PWS survey on treatment chemical management practices; and sample purchasing specifications.

Background

Chlorate is an inorganic compound that is a known byproduct of the drinking water disinfection process, forming when sodium or calcium hypochlorite (chlorine) or chlorine dioxide are used in the disinfection process. The amount of chlorate can vary considerably at different points within the distribution system and at different times of the year depending on water quality, the concentration of hypochlorite, the extent of degradation, and the method used to form chlorine dioxide. A number of compounds can react to release chlorate ions in water, including some herbicides, fireworks, and other explosives. For more information on chlorate see https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule#screening.

EPA has published a chlorate health reference level (HRL) of 210 parts per billion (ppb), which was based on thyroid effects seen in animals. HRLs are non-enforceable EPA contaminant levels for chemicals that are known or anticipated to occur in drinking water. These HRLs provide state agencies and other public health officials with human health effects information, analytical methodologies, and treatment technologies for the drinking water contaminant. HRLs are used to help determine whether the detection of the specific contaminant in drinking water or source waters for drinking water may indicate a potential health risk. For information on EPA's HRL see https://www.epa.gov/sites/production/files/2014-05/documents/final-ccl-3-contaminant-information-sheets.pdf. Exposure to high levels of chlorate may interfere with thyroid functions that are important for fetal and infant growth and development. Individuals with thyroid disease or nutritional deficiencies may be more sensitive to chlorate's effects on the thyroid. High levels of chlorate may also damage the kidneys and red blood cells. Individuals with anemia, other blood disorders or kidney disease may be more sensitive to these effects. More information about possible chlorate health effects can be found at: http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4135/epdf and https://www.awwa.org/Portals/0/files/legreg/documents/2014AWWAChlorateBriefingPaper.pdf.

EPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) required all public water systems (PWS) serving more than 10,000 persons to conduct assessment monitoring in their drinking water sources for 21 chemical contaminants, including chlorate, within a 12 month period during 2013 – 2015. A summary of the monitoring results for chlorate in Massachusetts are as follows:

	UCMR3 PWS[1]	UCMR3 Sources
Number of PWS and Sources participating in chlorate UCMR3 sampling	167	2168
Number and % of UCMR3 PWS and Sources detecting chlorate	143 (85%)	1559 (71%)
Number and % of UCMR3 PWS and Sources detecting chlorate over the EPA HRL	78 (46%)	368 (16%)

[1] According to MassDEP records 209 systems use calcium or sodium hypochlorite (chlorine) or chlorine dioxide and were not sampled under the USEPA UCMR3 because they did not meet the selection criteria for sampling. For more information on the UCMR3 selection criteria please see https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule

Similar results were observed nationally. For a copy of the UCMR3 results and other information on the UCMR3 please see:
https://www.mass.gov/lists/contaminants#unregulated-contaminants.

Outreach and BMP Information Collection

To assist PWS in Massachusetts to understand and manage chlorate development, MassDEP staff conducted in-depth interviews with 10 of the 78 PWS with chlorate detections over EPA's HRL. These systems had the highest levels of chlorate in the state. The purpose of these interviews was to identify potential sources of chlorate and to establish best management practices (BMPs) for reducing chlorate levels. The information collected during these interviews indicates that elevated levels of chlorate are often linked to the storage and handling procedures of sodium hypochlorite.

Following these interviews, MassDEP developed a chlorate survey, located at https://www.surveymonkey.com/r/56TCDMZ. In 2016, the survey was sent to all UCMR3 PWS with chlorate detects over the HRL. Seventy-five PWS were asked to complete the chlorate survey, and 64 responded (an 85 percent response rate). The Massachusetts Resource Authority (MWRA) responded on behalf of the 29 PWS that they fully serve.

Based on the information collected during the interviews and surveys, MassDEP compiled a list of Best Management Practices (BMPs) and recommendations for controlling chlorate. The BMPs are below. A complete summary of the PWS chlorate survey results is available later in this document.

Best Management Practices for the Control of Chlorate

- Generally, control of chlorate formation is a preferable method as opposed to having additional treatment for the removal of chlorate concentrations.
- Develop and keep up-to-date detailed purchasing specifications. Purchasing specifications promote the safe handling and delivery of bulk water treatment chemicals. (To see an example of a PWS Purchase Specifications see Chemical Purchase Specifications)
- Proper handling of chemicals is necessary.
- Delivery time of the hypochlorite solutions shipment should be minimized. Ideally, the delivery time should not exceed 72 hours from the time of manufacture to the time of delivery to the public water system.
- Storage time of chemicals should be minimized; both from the time of manufacture to delivery, and from the time of delivery to use at the PWS, reducing storage durations and the formation of chlorate in static solutions of sodium or calcium hypochlorite solutions.
- Reduce storage volume or strength, if possible.
- Chemical storage temperature is important. Keep storage temperature as low as possible.
- Hypochlorite solutions should be stored at temperatures below 20^{o} C with exposure to sunlight avoided.
- Hypochlorite solutions should be stored in diluted form to prevent chlorate formation.
- The pH for storage should be maintained in the 12 to 13 range, if possible.
- The specific gravity of the chlorite solution should be greater than 1.14.
- If ozonation is utilized, residual ozone should be completely removed by destruction since ozone can react with chlorine to form chlorates.
- Transition metals (e.g. iron, nickel, copper, zinc, chromium, and manganese) concentration should be kept low because of their catalytic effect in the decomposition of hypochlorite to

chlorate. If present in the water supply, these metals should be at a level less than 0.2 milligrams per liter (mg/L).

- Dilution can be a component of a control strategy because the rate of decomposition increases as the concentration of hypochlorite ion increases.
- Test hypochlorite degradation over time. A lack of monitoring of the free available chlorine (FAC) concentration in the stock of hypochlorite over time can lead some utilities to be unaware of hypochlorite deterioration and increasing concentrations of chlorate in the stored supply.
- Avoid mixing old and new hypochlorite.
- Periodic cleaning of bulk and day tanks is necessary.

Next Steps for MassDEP Drinking Water Program and PWS

MassDEP greatly appreciates the willingness of PWS to share their chemical storage and handling management practices. Several PWS offered to continue to work with MassDEP and peer groups to improve and share chlorate BMPs. The information collected during this survey shows that the likely cause of most of the elevated levels of chlorate in the surveyed PWS is linked to the storage and handling procedures of sodium hypochlorite. While 16 percent of the 2168 Massachusetts' UCMR3 PWS sources sampling results were above the EPA HRL, **84 percent of the sources showed chlorate levels below the HRL**. After in-depth interviews with the initial systems, several PWS reported identification and use of improved chlorate BMPs. These improvements indicate the need for more outreach and technical assistance to PWS on strategies and practices that can help to manage and minimize chlorate levels in finished water.

What is MassDEP doing to assist PWS to address hypochlorite or chlorine dioxide storage and handling?

- MassDEP is encouraging PWS to update their chemical handling procedures, and chemical application and use to keep chlorate levels as low as feasible without jeopardizing pathogen control.
- For systems with chlorate levels above the HRL MassDEP strongly recommends the implementation of BMPs and ongoing testing of chlorate levels to ensure the effectiveness of BMPs.
- MassDEP is providing technical assistance to PWS, with a priority for those who indicated a need for technical assistance and the 209 system that were not selected to participate in the UCMR3 sampling, to further identify and share BMPs for chlorate mitigation.
- MassDEP will be partnering with water works associations to identify opportunities for PWS to meet and share experiences with chlorate BMPs.
- MassDEP is developing video training materials on chlorate BMPs for distribution to PWS, targeted for release in mid-late 2017.

What should you do if your PWS uses calcium or sodium hypochlorite (chlorine) or chlorine dioxide and your system was not included in the USEPA UCMR3 sampling program?

- Review your chemical procurement, handling and storage practices to determine if you are using the best management practices outlined previously.
- Consider collecting a raw and entry point sample for chlorate. Please be aware that if you choose to collect chlorate samples the following is applicable:
    - You must use a laboratory from the USEPA UCMR3 list of certified laboratories located at https://www.epa.gov/dwucmr/list-laboratories-approved-epa-third-unregulated-contaminant-monitoring-rule-ucmr-3.
    - You must report the results to MassDEP via eDEP or on the unregulated contaminant form located at http://www.mass.gov/eea/agencies/massdep/water/drinking/water-systems-ops.html#41.

- If you are a community system you will have to include your chlorate result(s) in your annual Consumer Confidence Report (CCR). If you are a non-transient non-community (NTNC) system you must post the CCR report when it is provided to you by MassDEP.
- **If your results are at or above the USEPA HRL of 210 ppb, you will be contacted by a MassDEP technical assistance provider to discuss and assist you with BMP implementation.**

What should you do if your PWS does not currently use but is planning to use calcium or sodium hypochlorite (chlorine) or chlorine dioxide in the future?

- Contact your MassDEP Regional Office for technical assistance.
- Review available best design and management practices.
- Design and develop a plan that minimizes chlorate levels.
- Submit a permit application with plans and specifications to MassDEP for approval. *See Permit BRP WS 29 (http://www.mass.gov/eea/agencies/massdep/service/approvals/brp-ws-29.html) or BRP WS 34 (http://www.mass.gov/eea/agencies/massdep/service/approvals/brp-ws-34.html)*
- Follow MassDEP approval requirements including sampling, reporting and notification.

For more information on chlorate

See http://www.mass.gov/eea/agencies/massdep/water/drinking/lead-and-other-contaminants-in-drinking-water.html#23

For more information on purchasing specifications

See attached example Chemical Purchase Specifications for sodium hypochlorite.

For more information on BMPs

Additional information on BMPs may be found in the following AWWA article, "Perchlorate, bromate, and chlorate in hypochlorite solutions: Guidelines for Utilities" - Journal AWWA June 2011 (http://www.awwa.org/publications/journal-awwa/abstract/articleid/28067.aspx).

Do you need a Technical Assistance Provider to contact you?

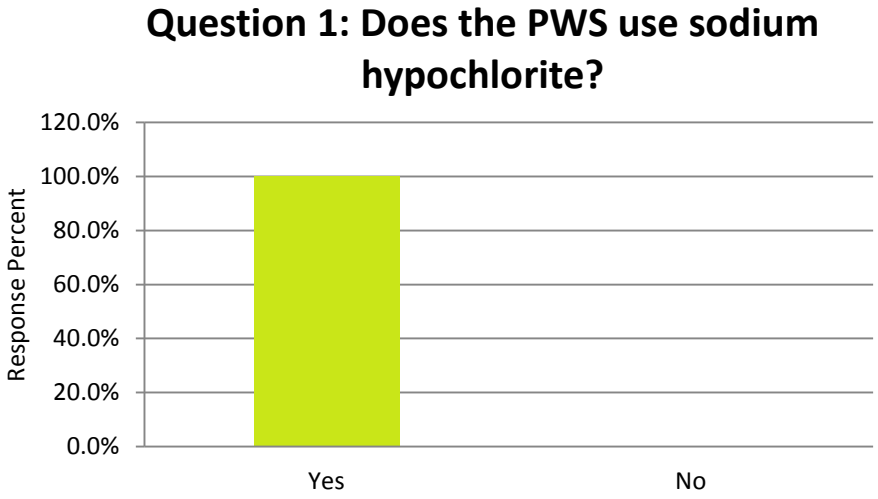
If you would like a technical assistance provider to contact you please contact:
Michael Maynard, MassDEP Drinking Water Program at 508-767-2735, Michael.Maynard@state.ma.us.

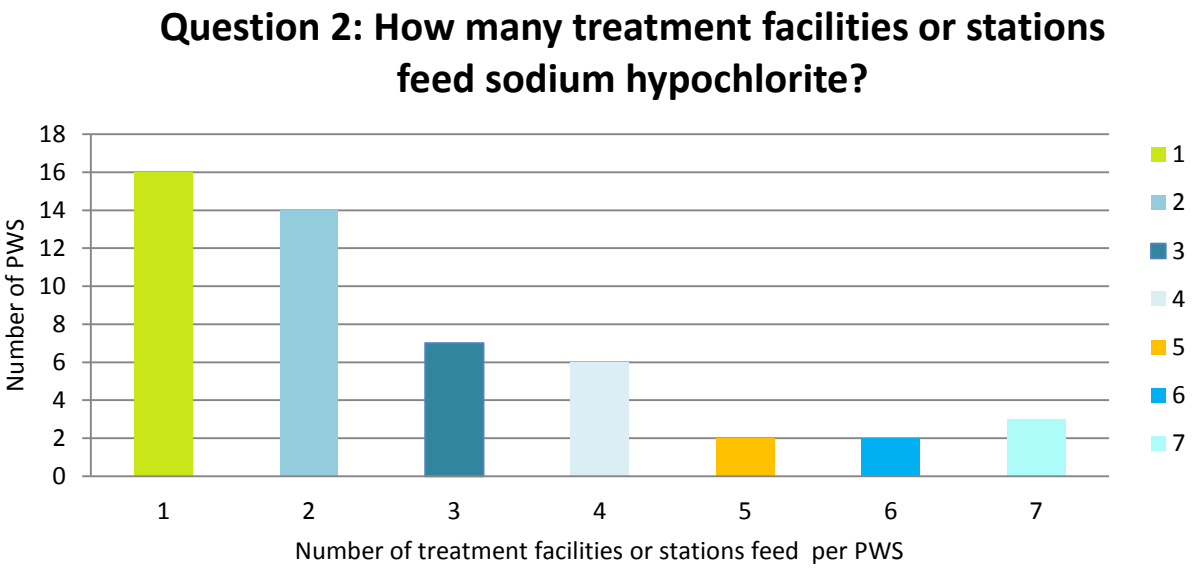
Who are your MassDEP Drinking Water Program UCMR contacts?

Location	Name	Phone #	Email Address
CERO	Paula Caron	508-767-2719	Paula.Caron@state.ma.us
NERO	Bill Zahoruiko	978-694-3232	William.Zahoruiko@state.ma.us
SERO	Charles Shurtleff	508-946-2879	Charles.Shurtleff@state.ma.us
WERO	Cathy Wanat	413-755-2216	Catherine.Wanat@state.ma.us
Boston	Steve Hallem Jessica Sibirski	617-292-5681 617-292-5599	Steve.Hallem@state.ma.us Jessica.Sibirski@state.ma.us
Drinking Water Program- program.director-dwp@state.ma.us 617-292-5770			

Summary of 2016 Chlorate Survey Questions and Responses

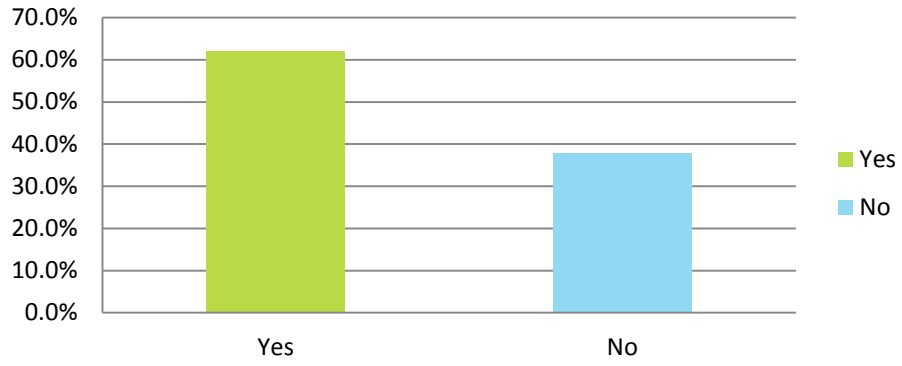
The following data summarizes the survey responses from 68 PWS with chlorate detections above HRL.





How many treatment facilities or stations feed sodium hypochlorite?	
# of facilities / stations per PWS	**Total # facilities/station**
1	*16*
2	*14*
3	*7*
4	*6*
5	*2*
6	*2*
7	*3*
Total	*50*

Question 3: Are all treatment facilities online at all times?

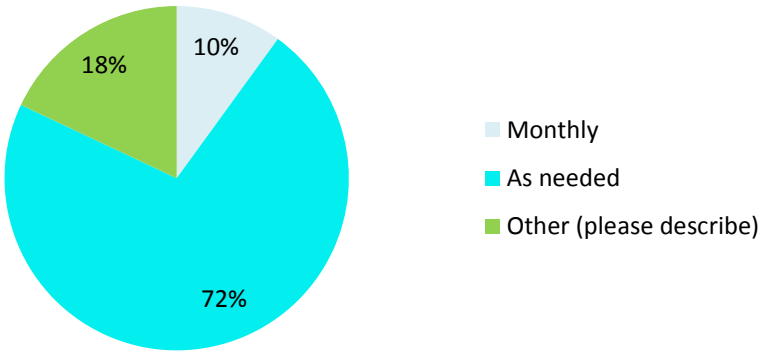


Are all treatment facilities online at all times?		
Answer Options	**Response Percent**	**Response Count**
Yes	62.0%	31
No	38.0%	19
Total		**50**

For the 38 percent of PWS that do not keep their facilities online at all times, some of the reasons are:

- *Facilities are only operated seasonally.*
- *Facilities are online as required to meet demand*
- *Active stations alternate as demand dictates*

Question 4: How often does the PWS receive deliveries?

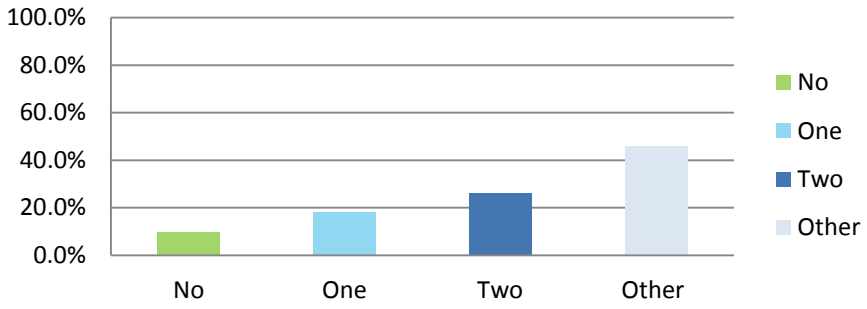


How often does the PWS receive deliveries?		
Answer Options	**Response Percent**	**Response Count**
Monthly	10.0%	5
As needed	72.0%	36
Other (please describe)	18.0%	9
Total		**50**

"Other" delivery schedules included:

- *Quarterly*
- *Once every 10 days*
- *Weekly during the summer and bi-weekly during the off season*

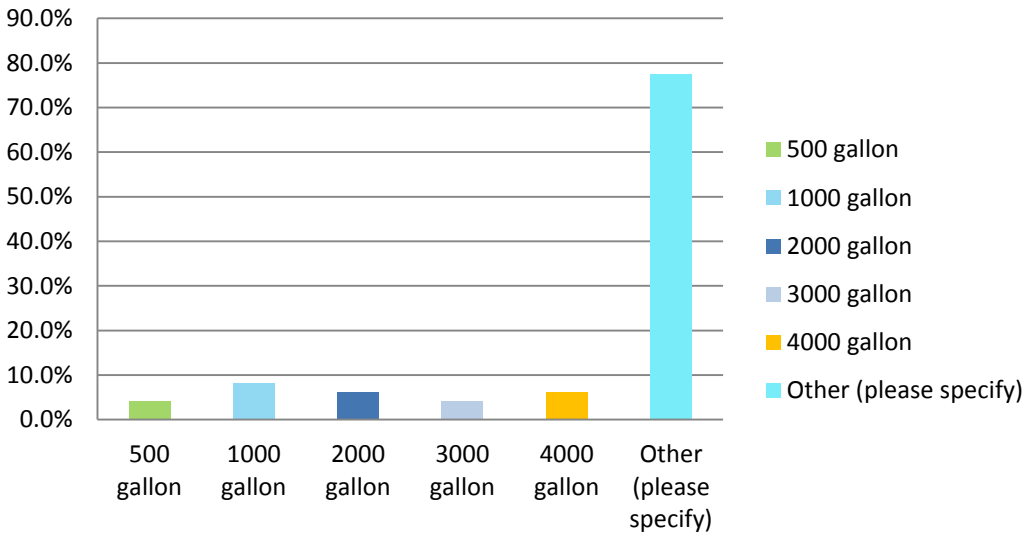
Question 5: Does the PWS have bulk tanks?



Does the PWS have bulk tanks?		
Answer Options	**Response Percent**	**Response Count**
No	10.0%	5
One	18.0%	9
Two	26.0%	13
Other (please specify)	46.0%	23
Total		**50**

"Other" respondents indicated that they had 3, 4, 5, or 6 bulk tanks.

Question 6: How large are the bulk tanks?

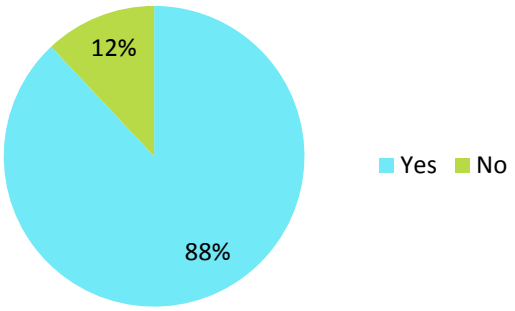


How large are the bulk tanks?		
Answer Options	**Response Percent**	**Response Count**
500 gallon	4.1%	2
1000 gallon	8.2%	4
2000 gallon	6.1%	3
3000 gallon	4.1%	2
4000 gallon	6.1%	3
Other (please specify)	77.6%	38
Total		**49**

"Other" sized bulk tanks included:

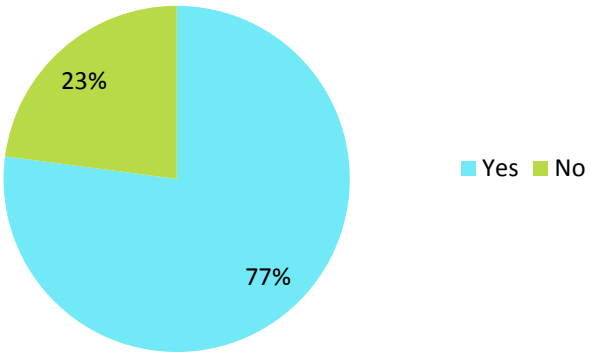
- *55 gallon*
- *5000 gallon drums*
- *8000 gallon*
- *9450 gallon*
- *12000 gallon*

Question 7: Does the PWS have day tanks?



Does the PWS have day tanks?		
Answer Options	**Response Percent**	**Response Count**
Yes	88.0%	44
No	12.0%	6
Total		**50**

Question 8: Is it possible to schedule the frequency of delivery to minimize the age of sodium hypochlorite?

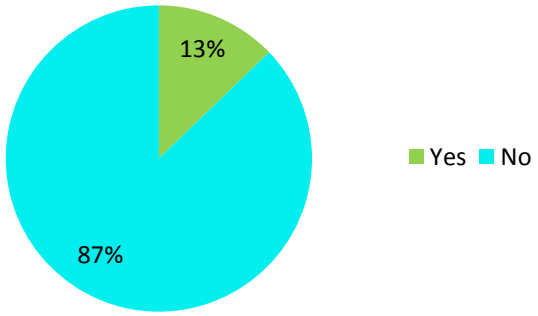


Is it possible to schedule the frequency of delivery to minimize the age of sodium hypochlorite?		
Answer Options	**Response Percent**	**Response Count**
Yes	77.0%	37
No	23.0%	11
Total		**48**

Of the 23 percent of respondents who indicated that altering chemical delivery was not possible, their reasons included:

- *"We try to time the deliveries to coincide with an empty bulk tank. But during the summer months we are at the mercy of the chemical suppliers."*
- *"The difficulty is deliveries do not always occur on the day you want them. If weekends or holidays are involved even more must be left in the bulk tank. Often seven days of bleach are expected to be in the tank at the time of delivery, to cover shipping problems, we must be able to use all stations in high demand times."*

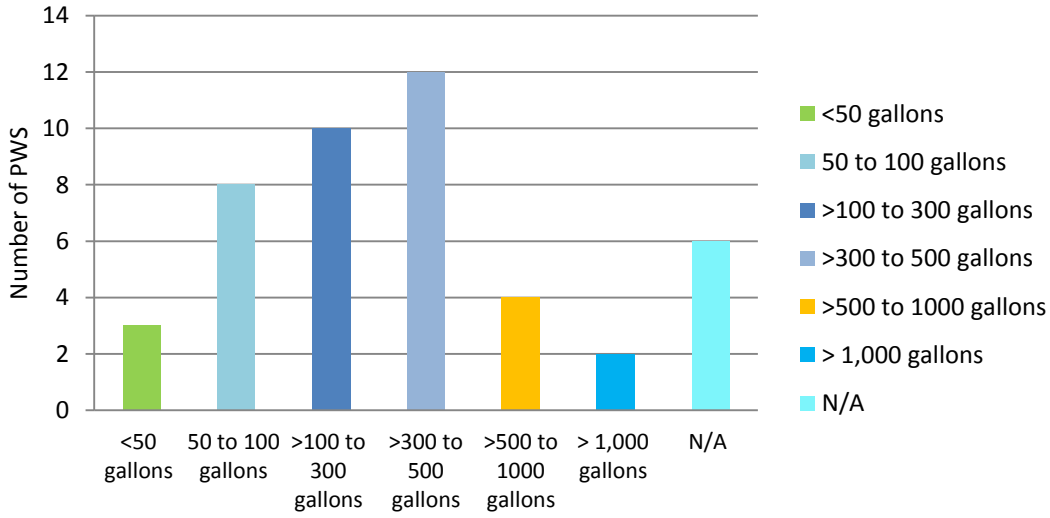
Question 9: Are the bulk tanks empty at time of delivery?



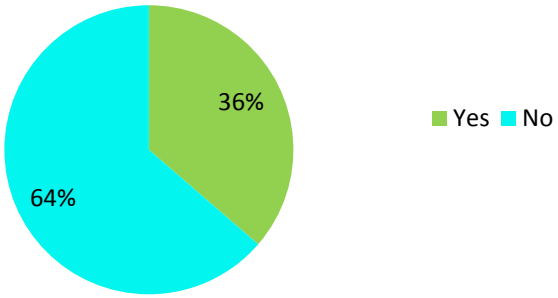
Are the bulk tanks empty at time of delivery?		
Answer Options	**Response Percent**	**Response Count**
Yes	12.8%	6
No	87.2%	41
Total		**47**

For PWS that answered no to the prior question, the amount of hypochlorite remaining at time of delivery is:

Question 10: How much hypochlorite is remaining at time of delivery?



Question 11: Is it possible to drain the bulk tank completely prior to delivery?

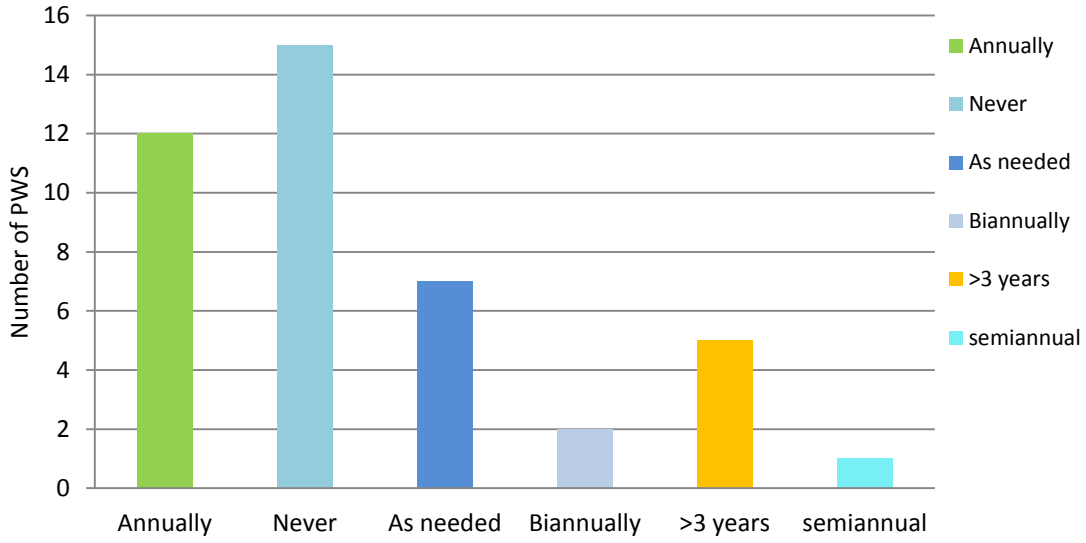


Is it possible to drain the bulk tank completely prior to delivery?		
Answer Options	**Response Percent**	**Response Count**
Yes	36.0%	17
No	64.0%	31
Total		**48**

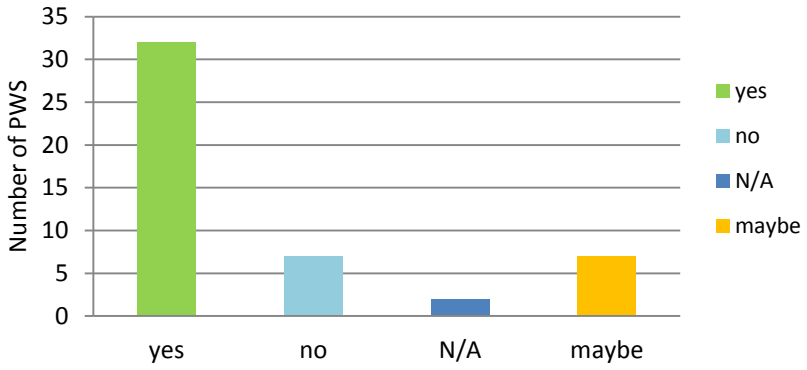
PWS that answered that it was not possible to drain their bulk tanks were asked to describe why. Some of their answers are:

- *"drain line is not flush with bottom of tank"*
- *"We risk losing prime to the suction side of the chemical feed pumps if we feed hypochlorite at a lower tank level."*
- *"Not plumbed for full drainage, it would have to be pumped out"*
- *"Lack of drain design/features for Clean In Place practices"*
- *"Difficult due to time of year and supplier being on time"*

Question 12: How often are the bulk tanks emptied and cleaned?



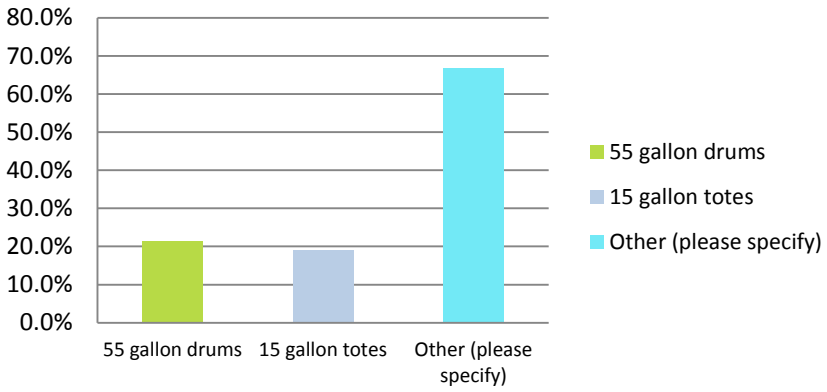
Question 13: Is it possible to increase the frequency of emptying and cleaning bulk tanks or day tanks?



Of the 14 percent of respondents that of do not believe increasing the turnover in their tanks, they cited difficulties such as:

- *"It would be extremely difficult for us to take wells offline in the summer months."*
- *"No - not practical."*

Question 14: Does the PWS use 55 gallon drums, 15 gallon totes, or other?



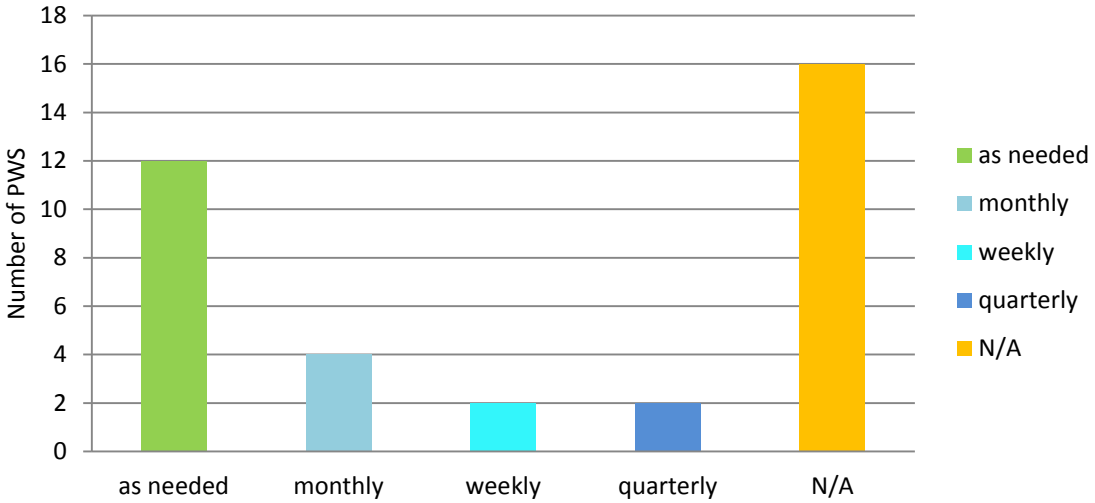
Does the PWS use 55 gallon drums, 15 gallon totes, or other?

Answer Options	Response Percent	Response Count
55 gallon drums	21.4%	9
15 gallon totes	19.0%	8
Other (please specify)	66.7%	28
Total		**42**

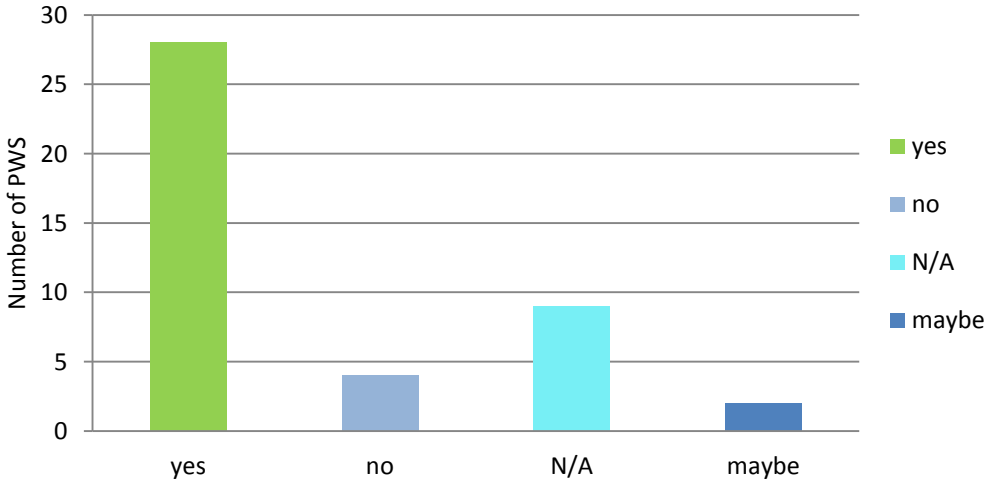
PWS that answered other specify the following:

- *5 gallon carboys*
- *5 gallon totes*
- *"We have used 300 gallon totes, not usually"*
- *"Day tanks draw from bulk tanks daily."*
- *"Only bulk storage tanks are used"*

Question 15: What is the frequency of delivery of drums or totes?



Question 16: Is it possible to schedule the frequency of delivery to minimize age of sodium hypochlorite?

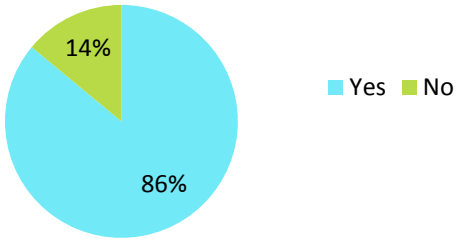


Question 17: List other measures the PWS can take to minimize the age of the sodium hypochlorite.

Some of the measures that respondents suggested PWS can take to minimize the age of the sodium hypochlorite are:

- Evaluate light/UV blocking bulk and day tanks when upgrading facilities.
- Keep tanks clean and manage the relationship/schedule between chemical usage and deliveries.
- Don't mix new chlorine with older inventory, use opaque storage drums in place of bulk storage where space allows, ask vendors to require Date of Production Guarantee.
- Dilute stored hypochlorite solutions on delivery. Store hypochlorite solutions at lower temperatures. Control the pH of stored hypochlorite solutions at pH 11-13, even after dilution. Avoid extended storage times and use fresh hypochlorite solutions when possible.
- A PWS stated that, "We require that the vendor supplies product within three days of manufacture. Upon delivery, operators confirm that the vendor is supplying newly-manufactured product. This PWS also rotates the storage tanks to avoid long detention times and reduction in strength. All sodium hypochlorite storage tanks are indoors and free from ultraviolet light exposure.

Question 18: Does the PWS require the manufacturer to meet maximum concentration limits for impurities in their delivery as a part of the purchasing specification?

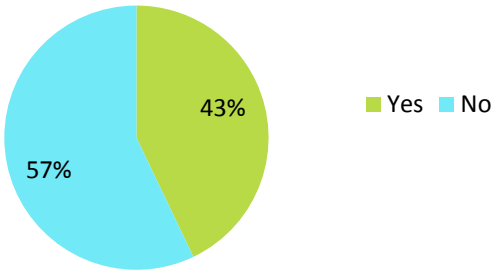


Does the PWS require the manufacturer to meet maximum concentration limits for impurities in their delivery as a part of the purchasing specification?		
Answer Options	**Response Percent**	**Response Count**
Yes	86.0%	43
No	14.0%	7
Total		**50**

Specifications provided by respondents included:

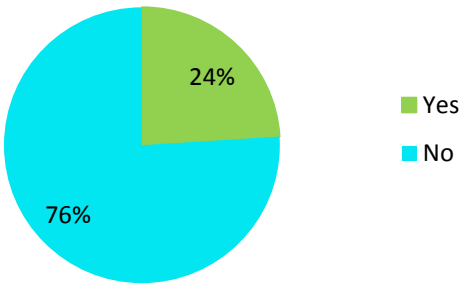
- *"yes, the manufacturer must meet AWWA B300 specifications"*
- *"the chemical consortium contract requires the manufacturer to meet AWWA standards which are specific to ANSI and NSF60 specifications"*
- *"Must meet the latest version of AWWA B301a-99"*
- *"We use the CommBUYS state bid for all drinking water chemicals"*
- *"12 percent minimum strength require, Contract operator supplies Hypo"*

Question 19: Does the PWS measure the strength of the sodium hypochlorite at time of delivery?



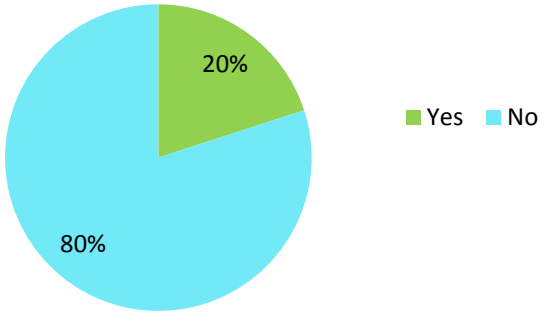
Does the PWS measure the strength of the sodium hypochlorite at time of delivery?		
Answer Options	**Response Percent**	**Response Count**
Yes	42.9%	21
No	57.1%	28
Total		**49**

Question 20: Does the PWS measure the strength of the sodium hypochlorite periodically during use?



Does the PWS measure the strength of the sodium hypochlorite periodically during use?		
Answer Options	**Response Percent**	**Response Count**
Yes	24.0%	12
No	76.0%	38
Total		**50**

Question 21: Does the PWS need additional technical assistance relative to chlorate issues?



Does the PWS need additional technical assistance relative to chlorate issues?		
Answer Options	**Response Percent**	**Response Count**
Yes	20.0%	10
No	80.0%	40
Total		**50**

Additional information or comments

Some of the additional comments and information provided by the respondents:

- "We design and operate our facilities in a manner that reduces Sodium Hypochlorite age to the maximum extent practicable while being able to provide uninterrupted service of high quality water to our customers. Many factors must be considered when coordinating chemical deliveries such as normal workday delivery schedules, maintaining adequate chemical supply over extended weekends, holidays, weather events (snowfall), high demand periods..."
- "Looking at the results, sampling dates and coordinating it with the specific chemical delivery dates, I have started some investigation into the process. Since the results were statistically the same at the entry point and distribution and the chemical onsite times were less than the 30 days suggested in AWWA's BMPs, it is not a treatment/operation or distribution water age issue that is the problem. Being that all the exceedances correlated to summer sampling times, I am trying to define if or how much summer time environmental temperatures play a part. Additionally, the seasonal plant is a membrane plant and when not in use stores the membranes in a high chlorine solution per manufacturer's O&M requirements. I am in conversation with them to see if there is severe chlorate formation possibilities and if the chlorate is somehow sequestered in the membranes that may release over time. I do have concerns about your questioning if operators test Chlorine concentration at the time of delivery or periodically. Being that the product is of a % level, I do not believe most water utilities have the time nor equipment to properly accomplish this."

- “The challenges that need to be overcome are: Bulk tanks that the pipes do not allow complete removal of the sodium hypochlorite because they do not go to the very bottom of the tank. There are also safety concerns of staff trying to power wash the inside of large bulk tanks while standing on a ladder about 12 feet off the ground. Because of access, and confined space issues, the staff cannot enter the bulk tanks. If pumps can be found to pump the sodium hypochlorite and wash down water out of the tank (due to the height of the tanks this is a challenge), which will have a high chlorine concentration, what do we do with this liquid? It will also be very important to completely remove any water that is added to the tank, to prevent changing chemical strength. Proper disposal methods of the tank washings will need to be developed. Developing a solution to emptying the tanks while keeping the station pumping, with a safety factor to cover delivery problems, will also be important.”

Example of PWS Sodium Hypochlorite Purchase Specifications

Chemical Purchase Specifications for **Sodium Hypochlorite** at the _____*Water Treatment Plant*
Revision number: ___ Revision Date: __/__/__ Pages: ___

1. **OBJECTIVE:** These purchase specifications are intended to promote the safe handling and delivery of bulk water treatment chemicals.

2. **RESPONSIBILITIES:** The *PWS* Project Manager shall update this purchase specification as needed; review the bid package submittal prior to award; and act as a contact with the *PWS* Purchasing department.

3. **SPECIFICATION PROVISIONS:**

   A. **Location:** Sodium hypochlorite shall be delivered via tank truck to the *XX Water Treatment Plant*.

Facility	Yearly Estimate	Typical Order Quantity

   B. **Start Date:** Estimated contract start date shall be determined by the Procurement Department. Date will be on or about _____.

   C. **Quantity**: The *PWS* anticipates using the annual quantities referenced above. This estimate is given for informational purposes only and shall not be deemed to either guarantee a minimum amount or restrict the maximum amount to be delivered.

   D. **Bid Package Requirements:**

   1. Vendors shall submit the following prior to contract award. The prospective vendor has *seven* business days from *PWS* notification to provide any missing items.

Table 1: Required Submittals
1. The Bulk Chemical Pre-Qualification Questionnaire.
2. Chemical Transportation Plan.
3. Emergency phone contact list for each company involved with generation, supply, and transportation of chemical to the facility.
4. Supply Plan.
5. Samples of each piece of delivery documentation.
6. A list of driver names.
7. A list of tank truck numbers.
8. A technical specification sheet.
9. The most recent scale weight station calibration report.
10. Local or state Bureau of Weights and Measures certification.
11. Material Safety Data Sheet.
12. An Independent Analysis for Impurities
13. A certification letter(s) stating that the chemical meets the AWWA standard and ANSI/NSF Standard 60

E. Vendor Selection:

1. Following the bid close, an interim period will be established where the *PWS* will evaluate the bids to determine the lowest, most responsible and responsive bidder. Site visits to the vendor's local manufacturing, distribution, or storage locations may be required. Site visits will be scheduled in advance with the vendor.

2. New vendors are required to conduct an initial site visit prior to commencement of the contract. The *PWS* staff will review contract requirements and policies for offloading chemical. The vendor shall conduct a site survey to ensure that the delivery area and storage location are suitable for offloading. The cost for this site survey shall be included in the vendor's bid price.

3. The *PWS* determination of the lowest, most responsible and responsive bidder shall consist of an evaluation of the bid price, all required submittals, supply capabilities, references, product quality, and certifications.

F. Quality:

1. The sodium hypochlorite shall be clear to pale yellow in color with no visual evidence of particulates in the product.

2. The delivery time of the shipment shall not exceed 72 hours from the time of manufacture. The term manufacture does not include shipping hypochlorite that is manufactured outside of the 72 hour window nor does it include diluting higher strength sodium hypochlorite that is manufactured outside of the 72 hour window. The manufacture date must be listed on the Certificate of Analysis.

3. Upon observation of particulates in the product or material accumulation in the storage tanks or associated process piping, the vendor shall, at a cost to the vendor, clean the affected equipment and dispose of the material in accordance with applicable state and federal regulations. The cleaning of affected equipment shall be coordinated with the *PWS* management.

4. Upon contract award the vendor may inspect a storage tank to see the cleanliness of the tank. The *PWS* may only be able to allow an inspection one tank at a time.

5. The vendor shall perform a suspended solids test on sodium hypochlorite sample prior to shipment. The test shall have the same test methods as the "Suspended Solids Quality Test for Bleach using Vacuum Filtration", developed by Dr. Bernard Bubnis of NovaChem. See http://powellfab.com/technical_information/files/3370.pdf . Product not within the specifications may be grounds for rejecting the delivery or generations of a letter of nonconformance.

6. The suspended solids in the sodium hypochlorite shall have a filtration time of less than 3 minutes for 1000 milliliters when applying the test method referenced above.

7. Sodium hypochlorite shall conform to the specifications listed in Table 2 and the maximum concentrations listed in Table 3. The Independent Analysis for Impurities shall disclose the results of these parameters.

Table 2

Note: The decision of solution strength is a local decision based on storage volume, pricing, etc.

Characteristic	**Requirement**
Solution strength*	14.5-16.5% trade
Excess sodium hydroxide	0.1-0.5% wt.
pH	11-13

Table 3

Note: The decision on appropriate levels of these contaminants is a local decision based on local source water characteristics.

Contaminant	**Concentration (mg/l)**	**Contaminant**	**Concentration (mg/l)**
Arsenic	1.50	Lead	2.00
Barium	2.00	Mercury	0.02
Cadmium	2.00	Nickel	0.10
Chromium (total)	2.00	Selenium	2.00
Cobalt	0.50	Silver	2.00
Copper	0.20	Chlorate	1500
Iron	1.00	Bromate	70
Perchlorate	85		

G. Certifications:

1. Sodium Hypochlorite shall conform to the latest ANSI/AWWA B300 Standard for Hypochlorites.

2. Sodium Hypochlorite shall be ANSI/NSF Standard 60 certified for drinking water chemicals. The chemical shall have been tested and certified by a product certification organization accredited for this purpose by the American National Standards Institute (ANSI).

3. Failure to comply with these requirements at manufacturing or transload facilities (if applicable) or the loss of ANSI/NSF 60 certification shall be considered grounds for non-issuance of contract or cancellation of this contract.

4. If ANSI/NSF Standard 60 certification is lost, the vendor shall notify the *PWS* Project Manager immediately.

H. Delivery Documentation:

1. At a minimum, the following are required with every delivery to the *PWS*: Bill of Lading, Certificate of Analysis, and a machine generated weight slip. The cost for these documents shall be included in the vendor's bid price.

2. The Vendor shall sample and test the chemical that is representative of the lot

being delivered. The Vendor shall highlight on the Certificate of Analysis whether or not the tests are performed on a bulk storage tank or directly from the loaded tank truck.

3. The following results shall be disclosed on each Certificate of Analysis.

Table 4	
Available chlorine (trade percent)	Chemical Name
Date of Manufacture	Appearance
Specific Gravity	Suspended Solids Test Filtration Time
Temperature	Signature of chemist or lab technician
Test Date	

4. The Certificate of Analysis shall list the test methods or analyzers used for each of these tests.

5. The Certificate of Analysis shall be signed and dated as proof of testing.

6. The following shall be disclosed on delivery documentation.
   a. Chemical name and grade
   b. Location from where sample was taken for the test (trailer, storage tank)
   c. The DOT UN number
   d. Tank truck number
   e. The initials and/or signatures of the driver and/or transloader.
   f. Ship to facility name and address
   g. Company name(s)
   h. Batch or Lot number

7. When the product is transloaded from a railcar to a tank truck the driver and/or transload facility employee must perform a visual sample inspection of both the railcar and tank truck and record their findings on a Transload Inspection Form.

8. Delivery documentation should clearly show product transfers that occur after manufacturing up to and including transfer into the vehicle that arrives at the *PWS* facility.

I. Purity Testing & Independent Analysis for Impurities:

1. The *PWS* will conduct strength and purity testing of the product throughout the contract period. If test results are unsatisfactory, a letter of nonconformance will be sent to the vendor at which time the vendor will be required to institute corrective actions. Continued non-compliance (more than four times per year) can result in vendor contract dismissal.

2. Prior to contract start the vendor shall submit an Independent Analysis for Impurities. Multi-year contracts require an annual submission as well. The cost shall be included in the vendor's bid price.

3. The Independent Analysis shall disclose results of the parameters listed in Table 2 and 3.

J. Chemical Transportation Plan:

1. The Transportation Plan shall include a detailed explanation of all companies affiliated with supplying the chemical to the *PWS* facility. This includes chemical manufacturer(s), distributor(s), repackager(s), and transporter(s). Explain how the chemical is manufactured, packaged, and what quality control and quality assurance measures are instituted to maintain product integrity. Discuss security measures at pertinent storage, manufacturing, railcar terminals, or repackaging locations.

2. For each manufacturer, distributor, and transporter provide a detailed list of chemicals that are also manufactured, repackaged, transported by each of the companies.

3. The vendor shall discuss whether product of differing strengths will be stored or transloaded at the local terminal. If so, the vendor shall disclose how they will segregate the products.

4. Any changes to the listed manufacturer(s), distributor(s), or transporter(s), require immediate notification to the *PWS*.

K. Supply Plan:

1. The Vendor shall submit a supply plan that highlights utilization of additional resources in the event of a planned or unplanned manufacturing plant shutdown, labor issues, weather emergency, or transportation issue (rail and/or tank truck). List alternate production locations and include a discussion of agreements with additional haulers and railcar storage terminals. Include a list of contact persons and emergency telephone numbers.

L. Containers & Appurtenances:

1. All containers and appurtenances shall be labeled for sodium hypochlorite.

M. Ordering:

1. Deliveries must be scheduled in advance. At the XXX Disinfection facility acceptable delivery times are during the hours of ___ a.m. and ___ p.m., Monday through Friday. At the XXX Water Treatment Plant acceptable delivery times are during daylight hours, seven days per week. Time or day exceptions can be made with the *PWS* approval.

2. The vendor will be expected to deliver product no later than 72 hours from the time a request has been made.

3. Tank truck deliveries may be ordered as partial loads. Deliveries may also allow for splitting a larger load between two or more *PWS* facilities. Orders cannot be combined in the same trailer compartment with other *PWS* facilities. If a compartment trailer is used the driver must provide a separate scale weight ticket for that compartment.

4. In the event that the vendor cannot or does not supply the product as requested the *PWS* reserves the right to purchase equivalent product at market prices for immediate delivery. The Vendor may be required to pay the cost difference.

5. When a date or dates are set for delivery of product, it shall be delivered on the scheduled date.

6. The vendor shall provide a twenty-four hour notice to *PWS* if the scheduled date cannot be met. Unanticipated problems that may cause delays require notification to the *PWS* within two hours. Numerous delays may be grounds for cancellation of contract.

7. The vendor may need to supply the chemical on an emergency basis and it is expected that the vendor is available to deliver chemical for emergencies 24 hours per day/7 days per week. Emergencies are considered a request for chemical with less than a twenty-four hour notice. The *PWS* will pay a flat fee for this service at a rate established on the Bid Proposal Form.

8. A request for an emergency delivery will be made by management to the vendor's emergency contact phone number. The *PWS* requests made to answering services or voice mails require a vendor call-back within one half-hour.

9. Vendors shall provide a list of holidays or other days in which deliveries normally cannot be sent to the *PWS*. This list shall be provided on the Pre-Qualification Questionnaire.

10. In the event of an emergency, the *PWS* reserves the right to ask the vendor to reroute a sodium hypochlorite delivery to another *PWS* facility.

N. Delivery:

1. Upon delivery arrival, an assigned *PWS* employee will review vehicle DOT placards and delivery documentation.

2. Tank trucks shall be equipped with a hatch or other suitable means of drawing samples for testing.

3. The driver shall provide a chemical sample from the tank truck. The *PWS* will provide sample bottles and will test the sample prior to offloading. No extra charges shall be assessed for sampling and testing.

4. The driver shall place chock blocks behind the wheels during offloading operations.

5. Each delivery must be accepted by the PWS personnel prior to offloading.

6. The driver shall carry the necessary quick connects and hosing to connect to the PWS fill connection. Connection size will be relayed to dispatch upon contract award. Vendors are responsible for adaptors, if necessary.

7. All drivers must place spill buckets underneath each hose connection. For added protection, they must also place cam straps around the cam locks. The driver is responsible for cleaning residual chemical that may leak out of a hose or be present in a hookup spill tray. The driver must have adequate spill absorbent material along with him or her in order to perform this task.

8. The driver must stay with the truck during offload operations.

9. Hoses shall be clean and free of residue from previous deliveries. They must also be free of cracks, tears, or wear that could result in a chemical spill. Hoses, couplings or adaptors found unclean shall be cleaned at the vendor's expense before unloading or the delivery may be rejected. The driver is responsible for bringing with him/her enough hose length in order to make all connections.

10. The transfer of chemicals from the tank truck shall be considered the responsibility of the Vendor's or Vendor's subcontractor tank truck driver.

11. The truck tank pressure shall be regulated by the driver while unloading and shall not exceed the tank truck manufacturer's specifications.

12. Any equipment found to be leaking chemicals shall be considered an emergency situation requiring immediate attention and response by the vendor or subcontractors. In such cases, the vendor must secure the services of an emergency response and cleanup contractor, working under the direction of a Licensed Site Professional, if required per 310 CMR 40.0000. The vendor must also notify state, local, and federal authorities in the appropriate time frames specified in 310 CMR 40.0000.

13. The *PWS* reserves the right to reject any delivery that does not conform to the specifications or which has been contaminated. In such circumstance, the Vendor shall bear the expense for removal and cleaning of PWS equipment.

14. Prior to departure, the driver shall notify the Control Room or designated *PWS* employee. He/she must make sure that all of the cargo has been unloaded and that all previously open vehicle outlets and valves are closed.

15. The vendor shall allow two hours offloading time without demurrage.

O. Safety and Personal Protective Equipment Requirements:

1. The vendor is responsible for providing company-required Personal Protective Equipment (PPE).

P. Training and Technical Services:

1. The PWS reserves the right to ask for a one-half day on-site classroom training to its employees. The training shall be delivered at no additional cost to the *PWS*.

2. The training session shall include but not limited to a discussion of the chemical characteristics, safe operation and maintenance chemical handling practices, personal protective equipment, and emergency response procedures.

3. The instructor shall have sufficient experience and qualifications that will enable him/her to present a training session that is meaningful and complete.

Q. Security:

1. Prior to the start of the contract, the *PWS* shall be provided with a list of driver names and trailer numbers. This list will be referenced by the *PWS* contracted security staff at facility entrance gates.

2. Updates to the driver name and trailer list shall be provided by fax to the manager in charge of the Quality Assurance or by mail and shall be on company letterhead.

3. All drivers may be required to present their Commercial Driver License (CDL). The PWS reserves the right to request copies of Commercial Driver's Licenses.

4. Security seals or locks shall be placed on the tank truck and railcars while in transport and at storage yards. The driver shall cut the tank truck seals in the presence of a PWS employee. If numbered seals are utilized, the seal numbers shall be referenced on the delivery documentation. The *PWS* employee will reference the paperwork to ensure the seal numbers match.

5. The vendor shall notify the *PWS* immediately in the event of broken seals or locks, and open or damaged dome covers on tank trucks or railcars.

6. Instances where the CDL is expired or questionable, or the driver name is not on the list will result in Supervisor notifications and possible delivery rejection.

R. Scale Weight Certificates & Certification:

1. Scale weight certificates, issued by a certified weigher, shall accompany all deliveries. The cost for this shall be included in the Vendor's bid price.

2. Submit copies of the scale weight certification, issued by the local or state Bureau of Weights & Measures, to the Project Manager annually following contract award.

3. Scale weight tickets must show the date, time, and trailer number in addition to the gross and tare weight.

4. All weights listed on the scale weight ticket shall be machine generated. Hand-written weights will not be accepted.

5. The *PWS* reserves the right to require the hauler, at any time during the contract period, to weigh its load at an independent weigh station. The independent weigh station will be within the local area of the *PWS* delivery drop-off. The vendor shall assume that this may be requested no more than once per year. In the event the weight is questioned the *PWS* reserves to the right to ask for one

additional weigh during the contract period. The *PWS* will pay for the weigh fee but will not pay for any lost-time fees associated with this request.

6. In instances where the *PWS* does not receive the entire load, the vendor shall provide the *PWS* with a second scale weight ticket (upon return to the vendor's facility). Therefore, the driver will have to re-weigh in order to get an accurate assessment of what was delivered to the *PWS*. This second scale weight ticket shall be faxed to the *PWS* on the same day as the delivery.

S. Fuel/Energy:

1. This contract is not subject to fuel or energy charges.

T. Payment:

1. Each invoice shall be submitted by the vendor using the following equation.

Step 1:	Net weight in pounds (from machine generated weight slip) (8.34 * Vendor's measured specific gravity) = Gallons of product delivered
Step 2:	Take answer from Step 1 * Contract price per gallon = Invoice amount

2. Invoices can be sent to PWS address

U. Drills:

1. The PWS reserves the right to exercise an annual unannounced drill whereby the *PWS* calls the Vendor's emergency contact number(s) and initiates an emergency chemical delivery to the *PWS*. This request can be made during working or non-working hours.

2. A request for an emergency delivery will be made by *PWS* management to the vendor's emergency contact phone number. *PWS* requests made to answering services or voice mails require a vendor call-back within one half-hour.

3. The PWS will pay a flat fee for this service at a rate established on the *PWS* Proposal Form. Emergency deliveries shall be delivered within four hours from PWS notification.

4. If the Vendor does not arrive in the four hour time period (includes time for filling tank truck and travel), the *PWS* reserves the right to ask for another drill during the calendar year. If the vendor fails again to arrive in the four hour time period, the *PWS* reserves the right to cancel any portion of or the entire contract.