APPENDIX A:

SANITARY SURVEYS AND REMEDIATION GUIDELINES FOR WATER RESOURCES

June 6, 2007

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EXECUTIVE SUMMARY

This report outlines Sanitary Surveys and Remediation Guidelines to be used as follow-up to situations encountered while using the decision trees and metric tables found in the *Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens.* This report provides an action plan when a water sample taken closest to the point-of-use has levels of generic *E. coli* above action levels.

For purposes of this report:

- A sanitary survey is an inspection of the entire water system, including water source, facilities, and equipment, for the purpose of identifying conditions that may result in microbial contamination.
- Remediation guidelines describe corrective actions corresponding to the conditions observed in the sanitary survey.

Sanitary surveys of water systems should also be conducted periodically to prevent contamination. Sanitary surveys:

- Reduce the risk of waterborne disease.
- Provide an opportunity to enhance your knowledge of your water system.
- Identify and document system deficiencies.

1.0 SANITARY SURVEY & REMEDIATION GUIDELINES

The Sanitary Surveys and Remediation Guidelines described below are to be used as follow-up to situations encountered while using the decision trees and metric tables found in the *Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens.* This document proscribes a Sanitary Survey be performed prior to the start of the growing season on water supplies and distribution systems used in the production of lettuce and leafy greens. In addition, there are some remediation approaches in this document that require that a Sanitary Survey be performed.

In a red-box situation when water samples taken closest to the point-of-use results in generic *E. coli* levels above an action level, a sanitary survey is initiated to determine any potential sources of contamination. In general, when conducting a sanitary survey the reliability, quality, and vulnerability of your water system are being investigated. To get started:

You have encountered a red box in a decision tree. Continue the investigative process as stated in the blue-box instructions in the decision tree:

1. Perform a generic *E. coli* test on a water sample taken at or as close to the source as possible. This result of this test will help to determine where the source of the contamination might reside. Depending on the results of this test, additional tests may be used to further narrow the exact location of the contamination entering the distribution system.

2. Initiate a Sanitary Survey of your water system:

    - Begin the Sanitary Survey process at the water source and continue surveying the water system between the water source and the site of the positive sample.

    - For specific water sources, follow the guidelines for conducting Sanitary Surveys and corresponding remediation outlined below.

1.1 Water sources

Whenever possible the sanitary survey should begin at the water system source as this is the first opportunity for controlling microbial contaminants. When investigating your water system source, you should identify the characteristics and activities that may lead to microbial contamination.

1.1.1 Wells

1.1.1.1 Sanitary Survey and Remediation Guidelines for Wells

Sanitary surveys of wells should focus on the integrity (meaning the state of repair) of the well components and the condition of the area surrounding the well. Inspect your wellhead on a regular basis and keep records of inspections and repairs.

WELL COMPONENTS

TABLE 1. Survey of Well Components

Well component	Survey Guidelines	Remediation guidelines
Well casing	Listen for water running down into the well. If you can hear water, there could be a crack or hole in the casing. If you can move the casing by pushing against it, you may also have a problem with the integrity of the casing. Well casing should extend at least 18 inches above the ground.	*Contact a well contractor or other trained individual for well casing repair or construction of a new well.
Annular space (The space between two well casings or between the casing and the wall of the drilled hole.)	The annular space of the well should have a minimum of 25 feet of sealing material.	*Contact a contractor or other trained individual for correction of a deficient annular space seal or construction of a new well.
Well cap or seal	Well should be completely sealed against surface water, insects, or other foreign matter. Look for holes, missing plugs, leaking water (artesian flow). If water is coming out, then contaminants can seep in.	Replace any missing plugs and seal any openings, gaps or cracks. *Contact a well contractor or other trained individual to install a new cap and/or wellhead gasket.
Well vent	Check the cleanliness & integrity of the well vent screen. Look for tears or holes.	Vents must be covered with a screen. Replaced damaged vent screen.
Concrete well pad	Look for cracks that would allow water to enter well casing.	Seal cracks or re-pour a new concrete pad. Ground should slope away from well so that surface water cannot collect near the well.
Well pump	Make sure pump is operating properly; check for corrosion.	Clean, repair or replace pump
*Many California counties' Departments of Environmental Health have listings of licensed contractors. Information taken from *A Guide For The Private Well Owner, Santa Clara Valley Water District, County of Santa Clara, Department of Environmental Health* and *Preparing for a Sanitary Survey: Information to Help Small Water Systems, WA State Dept of Health, DOH Pub.#331-238.*		

CONDITION OF THE AREA SURROUNDING THE WELL

Issues to consider when surveying the surrounding area are:

Proximity to:

- Livestock – including animal burial grounds, feedlots, manure pits/lagoons
- Sewers and septic systems
- Irrigation systems

TABLE 2. Survey of the Area Surrounding the Well

Issue	**Survey Guidelines**		**Remediation guidelines**
Cleanliness	Look for debris.		Manually remove debris.
Gradient	There is standing water around the well or water draining toward the well. Well is downstream from a potential contaminant source.		Re-grade around the well so the ground slopes away from your well. Move either the well or potential contaminant source.
Potential contaminant source	Minimum horizontal distance from:		
	Any sewer	50 ft.	Move either well or potential contaminant source to meet the minimum guidelines.
	Watertight septic tank or subsurface sewage leaching field	100 ft.	
	Cesspool or seepage pit	150 ft.	
	Animal enclosure	100 ft.	
Information taken from *DWR – Southern District Water Well Standards, Part II, Section 8* and *A Guide For The Private Well Owner, Santa Clara Valley Water District, County of Santa Clara, Department of Environmental Health*			

1.1.1.2 Remediation: Well Disinfection

If generic *E. coli* level in well water sample is above corresponding action levels, wells must be disinfected in order to remove the contamination. Follow the disinfection steps outlined below and keep records of when, why and how disinfection was done.

Disinfection involves seven steps:

Steps	Detailed Disinfection Instructions	Step Summary
1.	A chlorine solution containing at least 50 mg/l (or ppm - parts per million) available chlorine, is added to the well. Tables A-F in Appendices 1.1-1.3 lists quantities of various chloride compounds required to dose 100 feet of water-filled casing at 50 mg/l for diameters ranging from 2 to 24 inches. If bringing the well back into service quickly is desired (such as when wells have been repaired or when a pump has been repaired or replaced), the solution should contain at least 100 mg/l available chlorine. To obtain this concentration, double the amounts shown in Table X.	Using Table X to make a 50 ppm (mg/L) chlorine solution and add it to the well.
2.	To avoid adding contamination to the well during disinfection, first clean the work area around the top of the well. Remove grease and mineral deposits from accessible parts of the well head and flush the outside surfaces with chlorine solution (1/2 cup of laundry bleach in 5 gal of water). Turn off the pump. Remove the cap or the well plug on the rubber seal. There are many types of well caps and plugs. If you have questions, you should contact a licensed well driller. If you have a submersible pump, you may also want to contact a licensed well driller for advice on disinfection procedures. Wash the pump column, drop pipe, or anything inserted into the well with chlorine solution. Try to coat the sides of the casing as you pour. NOTE: To prevent later corrosion, thoroughly flush sensitive pump parts such as wiring with fresh water after disinfection process is completed.	Clean surrounding area & disinfect well head. Turn off the pump. Remove well cap. Wash sides of well casing, pump column, and anything inserted into the well with chlorine solution.
3.	After it has been placed into position, turn the pump on and off several times so as to thoroughly mix the disinfectant with the water in the well. Repeat this procedure **3-5x** at 1-hour intervals. Test for the presence of chlorine in well discharge with a residual chlorine test[1]; if chlorine is not detected, the disinfection process should be repeated.	Mix well water by turning pump on and off several times until discharge tests positive for residual chlorine. Repeat 3-**5x** at 1 hr intervals.
4.	The well shall be allowed to stand without pumping for 24 hours.	Let pump/well rest for 24 hours.
5.	The waste water shall then be pumped to land and contained. Avoid all water conveyance features such as swales, ditches, canals, creeks or streams. Do not allow overland flow to reach surface waters. Pump until presence of chlorine is not detectable. The absence of chlorine is best determined by testing for available chlorine residual.[1]	Pump water to a safe waste location until chlorine is no longer detected.

Steps	Detailed Disinfection Instructions	Step Summary
	NOTE: Heavily chlorinated water should not be discharged into any plumbing system that utilizes individual sewage disposal systems (septic tanks). Such strong disinfectants could neutralize the bacteria needed to stabilize the sewage and also could damage the soil adsorption system.	
6.	A bacteriological sample shall be taken and submitted to a laboratory for examination. For individual wells, technical advice regarding the collection of bacteriological samples may be obtained from your local health departments or from the laboratories that will examine the sample. If no technical assistance is available, use the following procedure: Use a sterile sample bottle, preferably one provided by the laboratory, and before sampling ensure that the sample bottle is properly labeled with location, date, and time of sampling. It is extremely important that nothing except the water to be analyzed come in contact with the inside of the bottle or the cap; the water must not be allowed to flow over an object (such as the hands) and into the bottle while it is being filled. If the water is collected from a sample tap, turn on the tap and allow the water to flow for 2 or 3 minutes before collecting the sample. Do not rinse the sample bottle. The sample should be delivered to the laboratory as soon as possible and in no case more than 30 hours after its collection. During delivery, the sample should be kept as cool as possible (but not frozen).	Take a water sample using sanitary techniques and submit it to a lab for testing.
7.	If the laboratory analysis shows the water is not free of bacterial contamination, the disinfection procedure should be repeated. Depending on the level of contamination, it may be necessary to use a higher concentration chlorine solution (several times that shown in Table **A-F in Appendices 1.1-1.3**). The water should then be retested. If repeated attempts to disinfect the well are unsuccessful, a detailed investigation to determine the cause of the contamination should be undertaken.	If testing shows microbial levels are still above acceptable action levels, repeat the disinfection process.

[1] Inexpensive color comparator residual chlorine test kits can be purchased from most large department stores and swimming pool supply companies.

Information taken from *DWR –Southern District, Water Well Standards, Appendix C.*

See Tables A-F in Appendices 1.1 – 1.3 for the amount of Chlorine Compound required to dose specific volumes of water-filled well casing at 50 milligrams per liter[1]

- Appendix 1.1 - 70% Calcium Hypochlorite[2] (Dry Weight) [3]
- Appendix 1.2 - 25% Chloride of Lime[3]
- Appendix 1.3 – 5.25% Sodium Hypochlorite[4]

1. Some authorities recommend a minimum concentration of 100 mg/L. See instructions given in Appendices to calculate higher concentrations.

2. HTH, Perchloron, Pittchlor, etc.

3. Where dry chlorine is used, it should be mixed with water to form a chlorine solution prior to placing it into the well. Note that dry chlorine should always be added to water, not vice versa. Further, the chemical should be added slowly. These precautions are necessary to lessen the possibility of a violent chemical reaction.

4. Household bleaches such as Chlorox, etc.

1.1.2 Surface Water in Canals, Laterals, and Ditches

1.1.2.1 Sanitary Survey and Remediation Guidelines for Surface Water

Sanitary surveys of canals, laterals, and ditches should focus on the integrity of surrounding bank systems focusing on potential point source and non-point source confluences (e.g. drainage into these systems). Inspections should occur on a regular basis. Keep records of the date of inspection and any observations made.

TABLE 3. Guidelines for Assessment of Surface Water

Issues	Survey Guidelines	Remediation guidelines
Animal of significant risk intrusion	Look for evidence of animals of significant risk (observed animal in canal, fecal deposits, or animal carcasses).	Remove animal debris; if animal intrusion is a regular occurrence, investigate the potential cause for intrusion.
Contaminating waters	Look for dirty/contaminated water that may be draining into the canal.	Redirect contaminating water with diversion dikes, gradients, inlet/outlet control structures, etc.
Cleanliness	Look for trash and debris accumulation.	Remove and dispose of items away from water.

1.1.2.2 Remediation by Disinfection

Management of microbial contamination in flowing water is difficult. If water source is not from a managed irrigation district, disinfection is not an option. If water source is from a managed irrigation district, contact the irrigation district manager. It may also be possible to treat (disinfect) water between pump and filter or after filter.

1.1.3 Well Reservoirs

1.1.3.1 Sanitary Survey and Remediation Guidelines for Well Reservoirs

Sanitary surveys of well reservoirs should focus on the condition of the source water, the integrity of the reservoir's surrounding bank system, and potential for contamination from both point source (e.g. animals of significant risk) and non-point sources (e.g. influent). Inspections should occur on a regular basis. Keep records of the date of inspection and any observations made.

TABLE 4. Guidelines for Assessment of Well Reservoirs

Issues	Survey Guidelines	Remediation guidelines
Contaminated well (source) water	Biannual or pre-production testing of source or well water as described in *Decision Tree for Well Head* reveals contamination.	Options: • Drain reservoir and allow to dry; disinfect connection system before refilling reservoir with disinfected well water. • Treat water as it is taken from the reservoir.
Animal of significant risk intrusion	Look for evidence of animals of significant risk (observed animal in reservoir, fecal deposits, carcasses).	Remove animal debris; if animal intrusion is a regular occurrence consider isolating reservoir and/or animals.
Contaminating influent	Look for dirty/contaminated water that may be draining into reservoir. Caution should be exercised when backflushing filtration systems so that this water does not return directory to the source.	Redirect water with diversion dikes, gradients, drainage pipes, inlet control structures, etc. A managed grassed buffer zone around reservoir (but not on banks) helps prevent contamination.
Overflow pipe	Observe whether opening is clean and free of weeds and debris.	Cover opening with a mesh screen.

1.2 Irrigation Systems

Contamination of irrigation systems can be avoided with proper maintenance and storage. Documented inspections should occur on a routine basis, and additionally when microbial levels of irrigation water are above acceptable levels.

1.2.1 Sanitary Survey for Irrigation Systems

1. Mechanical components
   - Check primary and secondary filtration equipment for cleanliness and proper function.

- Check for leaks on seals, gaskets, and fittings.

2. Water lines
   - Check water lines for visual evidence of microbial growth.[1]
     - white stringy slime
     - red filamentous sludge

   - For drip irrigation systems, use of chlorination treatment is advised if water source is not chlorinated.[2]
     - Because bacteria can grow in filters, inject chlorine upstream from filter units.
     - Chlorine may be injected continuously (at concentration of 1-2 ppm) or as a shock treatment (at concentrations of 10-30 ppm).

       A general formula for calculating the amount of chlorine for injection. (see footnote for an example)[a,1]

       IR = Q x C x 0.006/S

       Where IR = injection rate (gal/hr); Q = irrigation system flow rate (gal/min); C = the desired chlorine concentration (ppm); and S = strength of chlorine solution used (percent).

       Chlorine materials commonly used and their corresponding strength (S)[1]

       Sodium hypochlorite (household bleach): 5.25 - 15
       Calcium hypochlorite (dry): 65 - 70
       Chlorine gas: 100

     - It may be necessary to lower the pH during chlorination to increase the effectiveness of the microbial action.[3]
       - pH should be $\leq$ 7.0
       - acid and chlorine should be added to the system 2 to 3 feet apart
       - never combine chlorine and acid in the same container

   - Establish a documented regular maintenance schedule of inspection and flushing.

[a] Example: A grower wishes to use household bleach (NaOC at 5.25% active chlorine) to achieve a 3 ppm chlorine level at the injection point. The flow rate of his irrigation system is 90 gal/min. IR = 90 gal/min x 3 ppm x 0.006/5.25 = 0.31 gallon per hour. At an irrigation flow rate of 90 gal/min, the grower is pumping: 90 gal/min x 60 min = 5400 gal/hr. The goal is to inject 0.31 gallon of bleach into 5400 gallons of water each hour that injection occurs. If the injector is set for a 300:1 ratio, it will inject 5400/300 or 18 gal/hr. Then, 0.31 gallon of bleach should be added to 18 gallons of water in the stock solution. Note: be careful to use the same time units (hours) when calculating the injection rate.[1]

[1] Clark, G., Lamont, W., Marr, C., Rogers, D., (1996) Maintaining Drip Irrigation Systems, Kansas State University, Commercial Vegetable Production.

[2] Benham, B., Ross, B., (2002), Filtration, Treatment, and Maintenance Considerations for Micro-Irrigation Systems, Virginia Cooperative Extension, Pub. No. 442-757.

[3] Note: Chlorine in solution exists as hypochlorus acid (HOC) and hypochlorite (OC-). HOC is 40-80x more effective at killing microorganisms than OC- and water with a lower pH increases the amount of HOC. [1]

1.3 Finished water storage

The water storage tank site should be well maintained and properly graded. The tank should be located away from livestock and septic systems.

1.3.1 Sanitary survey for finished water storage tank

1. Area around the tank:
   - Whether it is on the ground or elevated, the base of the tank should be visible
   - Should be clean and free of debris and weeds

2. On a quarterly basis inspect each finished water storage tank to ensure:
   - Structural soundness (interior and exterior damage or rust)
   - No vegetation is growing on tank
   - Access hatch lids are properly gasketed and secured
   - If vents are present, they should be adequately screened with a corrosion resistant material
   - The overflow and drain pipes are screened and have proper air gaps

3. Tanks should be cleaned every 3-5 years.

1.3.2 Remediation: Disinfection

If water in storage tank tests positive for generic *E. coli*, contact a water system contractor or other trained individual to clean and disinfect the tank.

1.4 Water distribution system

Since almost all of the distribution system components are underground, a map of your water distribution system would be helpful. If however, a map is not available, check exposed components for any vulnerability to contaminants. Signs of damaged underground components may include unexplained erosion or patches of lush green grass.

1.4.1 Cross connections

As part of the Sanitary Survey, check for cross connections in your water system. The EPA defines a cross connection as an actual or potential physical connection between a water system and another water source of unknown or questionable quality. The physical connection could allow water of questionable quality to backflow into the water system. Cross connections occur in places where proper air gaps between water surfaces and water sources are not maintained and therefore allowing flow reversals. An example of a cross connection is a hose with one end attached to a water line and the other end lying in a tub of water, a fountain base, or a fish pond.

TABLE 5. Sanitary Survey of Distribution System

Issues	Remediation Guidelines
There are cross-connections in the plumbing system.	Make sure that your plumbing is not connected to another source of water that may be contaminated (e.g. a defunct community water system).
There is not adequate back-flow protection.	Install a back-flow prevention device on every outdoor faucet (available at most hardware and plumbing supply stores).
There are dead-end or unused water lines connected to your plumbing system.	Flush lines regularly or remove any used lines or sections of the water system.
There are abandoned or inactive wells on my property.	When no longer in use, wells must be destroyed to prevent them from functioning as a vertical conduit for contaminants.

2.0 SUMMARY AND CONCLUSIONS

- Have your entire water system checked annually by a licensed contractor or other trained individual, and as required in the decision trees in the 2nd Edition of the *Commodity Specific Food Safety Guidelines for the Lettuce and Leafy Greens Supply Chain* .

- Keep detailed records of every Sanitary Survey. Documentation should include:
    - Date
    - A description of the condition of the water system
    - Location and description of problem areas and the corresponding repairs and/or resolutions.

3.0 REFERENCES

California Department of Water Resources. *Water Well Standards.* California Department of Water Resources, Division of Planning and Local Assistance, Southern District.

Miller, TH. 2006. *Septic Systems and their maintenance.* Maryland Cooperative Extension, University of Maryland. August.

Santa Clara Valley Water District. *A Guide For The Private Well Owner*. County of Santa Clara, Department of Environmental Health.

Vogel, MP. 2005. *Septic Tank and Drainfied Operation and Maintenance.* Montana State University Extension Service: MontGuide. August.

Washington State Department of Health. 2005. *Preparing for a Sanitary Survey: Information to Help Small Water Systems*. Washington State Department of Health, Division of Environmental Health, Office of Drinking Water..

Appendix 1.1: Conversion table for calculating the amount of (70%) Calcium Hypochlorite required to dose specific well volumes at 50 mg/L.

Table A

(70%) Calcium Hypochlorite (Dry Weight in ounces)	Length of Pipe Containing Water (ft)																		
Pipe Diameter (inch)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
2	0.25	0.24	0.23	0.21	0.20	0.19	0.18	0.16	0.15	0.14	0.125	0.1125	0.1	0.0875	0.075	0.0625	0.05	0.0375	0.025
4	1	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10
6	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20
8	3	2.9	2.7	2.6	2.4	2.3	2.1	2.0	1.8	1.7	1.5	1.4	1.2	1.1	0.9	0.75	0.6	0.45	0.3
10	4	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.2	2	1.8	1.6	1.4	1.2	1	0.8	0.6	0.4
12	6	5.7	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3	2.7	2.4	2.1	1.8	1.5	1.2	0.9	0.6
16	10	9.5	9	8.5	8	7.5	7	6.5	6	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
20	16	15.2	14.4	13.6	12.8	12	11.2	10.4	9.6	8.8	8	7.2	6.4	5.6	4.8	4	3.2	2.4	1.6

Table B

This Table uses Metric Units													**This Table uses Metric Units**					
(70%) Calcium Hypochlorite (Dry Weight in grams)	Length of Pipe Containing Water (ft)																	
Pipe Diameter (inch)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
2	7	6.7	6.3	6.0	5.6	5.3	4.9	4.6	4.2	3.9	3.5	3.2	2.8	2.5	2.1	1.8	1.4	1.1	0.7
4	28	27	25	24	22	21	20	18	17	15	14	13	11	10	8	7	6	4	3
6	57	54	51	48	46	43	40	37	34	31	29	26	23	20	17	14	11	9	6
8	85	81	77	72	68	64	60	55	51	47	43	38	34	30	26	21	17	13	9
10	113	107	102	96	90	85	79	73	68	62	57	51	45	40	34	28	23	17	11
12	200	190	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20
16	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60	45	30
20	450	428	405	382.5	360	337.5	315	292.5	270	247.5	225	202.5	180	157.5	135	112.5	90	67.5	45
**1000 g = 1 Kg				**This Table uses Metric Units**								**This Table uses Metric Units**					**1000 g = 1 Kg		

How to use these tables:

Step 1: Determine the pipe diameter of your well in inches.

Step 2: Determine the well depth (or pipe length) of your well in feet (The company that constructed the well should be able to provide you with the well depth if you do not have it in your records).

Step 3: Determine the water level in your well (in feet).

Step 4: Subtract the well depth from the water level and this will give you the length of pipe containing water (ft).

Step 5: Using the tables above, match up your pipe diameter with your calculated length of pipe containing water to determine the amount of (70%) Calcium Hypochlorite required (Example – If you have a well that has a pipe diameter of 6 inches and a length of pipe containing water that is 60 ft, you would use 1.2 oz or 29 g of (70%) Calcium Hypochlorite).

Step 6: Decide what concentration of chlorine is required for the well disinfection. If you want to use a 50 mg/L chlorine solution, use the number that you derived in the table. If you want a **100 mg/L chlorine solution,** use the number that you derived in the table **multiplied by 2**. If you want a **200 mg/L chlorine solution,** use the number that you derived in the table **multiplied by 4**.

Step 7: **NOTE** – If you are going to weigh out your (70%) Calcium Hypochlorite in **grams – USE TABLE B – These numbers are metric**.

Appendix 1.2: Conversion table for calculating the amount of (25%) Chloride of Lime required to dose specific well volumes at 50 mg/L.

Table C																			
(25%) Chloride of Lime (Dry Weight in ounces)								Length of Pipe Containing Water (ft)											
Pipe Diameter (inch)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
2	0.50	0.48	0.45	0.43	0.40	0.38	0.35	0.33	0.30	0.28	0.25	0.23	0.20	0.18	0.15	0.13	0.10	0.08	0.05
4	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
6	4	3.8	3.6	3.4	3.2	3	2.8	2.6	2.4	2.2	2	1.8	1.6	1.4	1.2	1	0.8	0.6	0.4
8	7	7	6	6	6	5	5	5	4	3.9	3.5	3.2	2.8	2.5	2.1	1.8	1.4	1.1	0.7
10	11	10	10	9	9	8	8	7	7	6.1	5.5	5.0	4.4	3.9	3.3	2.8	2.2	1.7	1.1
12	16	15.2	14.4	13.6	12.8	12	11.2	10.4	9.6	8.8	8	7.2	6.4	5.6	4.8	4	3.2	2.4	1.6
16	32	30	29	27	26	24	22	21	19	18	16	14	13	11	10	8	6	5	3
20	48	46	43	41	38	36	34	31	29	26	24	22	19	17	14	12	10	7	5

Table D	**This Table uses Metric Units**												**This Table uses Metric Units**						
(25%) Chloride of Lime (Dry Weight in grams)								Length of Pipe Containing Water (ft)											
Pipe Diameter (inch)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
2	14	13.3	12.6	11.9	11.2	10.5	9.8	9.1	8.4	7.7	7	6.3	5.6	4.9	4.2	3.5	2.8	2.1	1.4
4	57	54	51	48	46	43	40	37	34	31	29	26	23	20	17	14	11	9	6
6	113	107	102	96	90	85	79	73	68	62	57	51	45	40	34	28	23	17	11
8	200	190	180	170	160	150	140	130	120	110	100	90	80	70	60	50	40	30	20
10	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60	45	30
12	450	428	405	383	360	338	315	293	270	248	225	203	180	158	135	113	90	68	45
16	900	855	810	765	720	675	630	585	540	495	450	405	360	315	270	225	180	135	90
20	1400	1330	1260	1190	1120	1050	980	910	840	770	700	630	560	490	420	350	280	210	140
**1000 g = 1 Kg				**This Table uses Metric Units**								**This Table uses Metric Units**				**1000 g = 1 Kg			

How to use these tables:
Step 1: Determine the pipe diameter of your well in inches.
Step 2: Determine the well depth (or pipe length) of your well in feet (The company that constructed the well should be able to provide you with the well depth if you do not have it in your records).
Step 3: Determine the water level in your well (in feet).
Step 4: Subtract the well depth from the water level and this will give you the length of pipe containing water (ft).
Step 5: Using the tables above, match up your pipe diameter with your calculated length of pipe containing water to determine the amount of (25%) Chloride of Lime required (Example – If you have a well that has a pipe diameter of 6 inches and a length of pipe containing water that is 60 ft, you would use 2.4 oz or 68 g of (25%) Chloride of Lime).
Step 6: Decide what concentration of chlorine is required for the well disinfection. If you want to use a 50 mg/L chlorine solution, use the number that you derived in the table. If you want a **100 mg/L chlorine solution,** use the number that you derived in the table **multiplied by 2**. If you want a **200 mg/L chlorine solution,** use the number that you derived in the table **multiplied by 4**.
Step 7: **NOTE** – If you are going to weigh out your (25%) Chloride of Lime in **grams – USE TABLE D – These numbers are metric**.

Appendix 1.3: Conversion table for calculating the amount of (5.25%) Sodium Hypochlorite required to dose specific well volumes at 50 mg/L.

Table E																			
(5.25%) Sodium Hypochlorite (Liquid Measure in fluid ounces)								Length of Pipe Containing Water (ft)											
Pipe Diameter (inch)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
2	2	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2	1.1	1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
4	9	8.6	8.1	7.7	7.2	6.8	6.3	5.9	5.4	5	4.5	4.1	3.6	3.2	2.7	2.3	1.8	1.4	0.9
6	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
8	34	32	31	29	27	26	24	22	20	19	17	15	14	12	10	9	7	5	3
10	56	53	50	48	45	42	39	36	34	31	28	25	22	20	17	14	11	8	6
12	80	76	72	68	64	60	56	52	48	44	40	36	32	28	24	20	16	12	8
16	128	122	115	109	102	96	90	83	77	70	64	58	51	45	38	32	26	19	13
20	170	162	153	145	136	128	119	111	102	94	85	77	68	60	51	43	34	26	17

Table F	**This Table uses Metric Units**													**This Table uses Metric Units**					
(5.25%) Sodium Hypochlorite (Liquid Measure in milliliters)								Length of Pipe Containing Water (ft)											
Pipe Diameter (inch)	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
2	59	56	53	50	47	44	41	38	35	32	30	27	24	21	18	15	12	9	6
4	266	253	239	226	213	200	186	173	160	146	133	120	106	93	80	67	53	40	27
6	600	570	540	510	480	450	420	390	360	330	300	270	240	210	180	150	120	90	60
8	1000	950	900	850	800	750	700	650	600	550	500	450	400	350	300	250	200	150	100
10	1700	1615	1530	1445	1360	1275	1190	1105	1020	935	850	765	680	595	510	425	340	255	170
12	2400	2280	2160	2040	1920	1800	1680	1560	1440	1320	1200	1080	960	840	720	600	480	360	240
16	3800	3610	3420	3230	3040	2850	2660	2470	2280	2090	1900	1710	1520	1330	1140	950	760	570	380
20	6300	5985	5670	5355	5040	4725	4410	4095	3780	3465	3150	2835	2520	2205	1890	1575	1260	945	630
**1000 mL = 1 L				**This Table uses Metric Units**								**This Table uses Metric Units**				**1000 mL = 1 L			

How to use these tables:

Step 1: Determine the pipe diameter of your well in inches.

Step 2: Determine the well depth (or pipe length) of your well in feet (The company that constructed the well should be able to provide you with the well depth if you do not have it in your records).

Step 3: Determine the water level in your well (in feet).

Step 4: Subtract the well depth from the water level and this will give you the length of pipe containing water (ft).

Step 5: Using the tables above, match up your pipe diameter with your calculated length of pipe containing water to determine the amount of (5.25%) Sodium Hypochlorite required (Example – If you have a well that has a pipe diameter of 6 inches and a length of pipe containing water that is 60 ft, you would use 12 oz or 360 mL of (5.25%) Sodium Hypochlorite).

Step 6: Decide what concentration of chlorine is required for the well disinfection. If you want to use a **50 mg/L chlorine solution**, use the number that you derived in the table. If you want a **100 mg/L chlorine solution,** use the number that you derived in the table **multiplied by 2**. If you want a **200 mg/L chlorine solution,** use the number that you derived in the table **multiplied by 4**.

Step 7: **NOTE** – If you are going to weigh out your (5.25%) Sodium Hypochlorite in **milliliters – USE TABLE F – These numbers are metric**.